DOCUMENT RESUME

ED 301 462 SE 050 184

TITLE	Federal R&D Funding by Budget Function. Fiscal Years 1987-1989.
INSTITUTION	National Science Foundation, Washington, D.C. Directorate for Scientific, Technological and International Affairs.
REPORT NO	NSF-88-315
PUB DATE	Apr 88
NOTE	124p.; For 1986-1989 report, see ED 286 729. Pages with small print may not reproduce well.
PUB TYPE	Reports - Descriptive (141) -- Reports - Research/Technical (143)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	*Federal Aid; *Financial Support; Government Role; National Security; *Public Agencies; *Research and Development; Research Universities; Science Education; *Scientific Research

ABSTRACT

This annual report provides an analysis of federal research and development (R&D) funding by functional classification based on data in the President's budget. It includes only federal funding of R&D programs and excludes R&D facilities and all non-R&D activities. This report is designed to facilitate examination of the relative importance of R&D in the overall federal budget, as well as the role of each function within the total federal R&D effort. Functional classifications considered include: (1) "National Defense"; (2) "Health"; (3) "Space Research and Technology"; (4) "General Science"; (5) "Energy"; (6) "Transportation"; (7) "Natural Resources and Environment"; (8) "Agriculture"; (9) "Education, Training, Employment, and Social Services"; (10) "International Affairs"; and (11) "All Other Functions." An appendix considers historical trends. Additional analyses include total R&D statistics and basic research. (CW)

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FEDERAL R&D FUNDING BY BUDGET FUNCTION

FISCAL YEARS 1987-1989

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NATIONAL SCIENCE FOUNDATION
Directorate for Scientific, Technological, and International Affairs
Division of Science Resources Studies
Government Studies Group

Washington, D.C.
20550

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ACKNOWLEDGEMENTS

This report was prepared in the Division of Science Resources Studies (SRS) by the Government Studies Group (GSG) staff: Vanessa Richardson, John Tsapogas, Margaret Meredith, and Richard Bennof. Supervision, review and guidance were provided by Margaret R. Grucza, Study Director, GSG, Charles H. Dickens, Head, Surveys and Analysis Section, and William L. Stewart, Director, SRS.

PREFACE

This annual report provides an analysis of Federal research and development (R&D) funding by functional classification based on data in the President's budget. This report includes only Federal funding of R&D programs and excludes R&D facilities and all non-R&D activities. R&D program data are classified into the same budget functions used in the Budget of the United States Government to facilitate examination of the relative importance of research and development in the overall Federal budget, as well as the role of each function within the total Federal R&D effort.

All programs within the Federal budget are classified into functional categories. Funding for these 19 functions (plus allowances and undistributed offsetting receipts) comprise the budget total with no overlap occurring between functions or the agency programs within the functions. Functional categories and definitions used in this report are the same as those used in the Federal budget, with one exception. The Federal budget function of general science, space, and technology has been divided into two R&D functions: space research and technology and general science. Four Federal budget functions: medicare, social security, general purpose fiscal assistance, and net interest have no R&D components and are therefore excluded from this report. The agency/function crosswalk table on the next page presents a listing of the agencies contributing support to the 16 individual R&D functions.

The overview section examines the total R&D budget and basic research funding. The individual functions are presented in descending order of R&D budget authority for fiscal year 1989. The data in this report, with a few noted exceptions, are based on budget authority dollars rather than obligations or outlays since detailed agency budgets with information at the program level are available only in budget authority. 1/ Each section includes an overview of the function and a summary table, followed by more detailed tables and text describing the major R&D program areas within the function, all of which are also presented in descending order of 1989 budget authority. Over 500 R&D programs are identified with their actual budget authority levels for fiscal year 1987, estimated levels for fiscal year 1988 and proposed funding levels for fiscal year 1989.

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[1] Budget authority is the legal authorization that permits obligations to be incurred. Obligations represent the amounts for orders placed, contracts awarded, services received, and similar transactions during a given period, regardless of when the funds were appropriated and when future payment of money is required. Outlays represent the amounts for checks issued and cash payments made during a given period, regardless of when the funds were appropriated.

AGENCY/FUNCTION CROSSWALK: FISCAL YEARS 1987-89

AGENCIES	National defense	Health	Space research and technology	Energy	General science	Transportation	Natural resources and environment	Agriculture	International affairs	Veterans benefits and services	Education, training, employment and social services	Commerce and housing credit	Community and regional development	Administration of justice	Income security	General government
Dept of Defense (Mil)	X															
Dept of Hlth & Human Svcs.		X									X				X	
Dept of Energy	X			X	X											
Nat'l Aeronautics & Space Admin.			X			X										
Nat'l Science Foundation					X											
Dept of Agriculture							X	X								
Dept of Transportation						X										
Dept of Interior							X									
Environmental Protection Agency				X			X									
Dept of Commerce							X					X	X			
Agency for Internat'l Dev.									X							
Veterans Administration										X						
Nuclear Regulatory Commission				X												
Dept of Education											X					
Tennessee Valley Authority													X			
Smithsonian Institution											X					
Dept of Justice														X		
Corps of Engineers-Civil Works							X									
Dept of Housing & Urban Dev.													X			
Dept of Labor		X									X				X	
Dept of Treasury														X		X

For reference, a series of historical tables covering Federal R&D funding by function for the period 1955-89 and basic research for 1978 to 1989 are included in the Appendix.

In the Federal budget, most appropriations for research and development are not labeled as such, but are included within general program funding. In order to reach an overall Federal R&D total for analytical purposes, the Office of Management and Budget (OMB) requires the agencies to submit data on their R&D programs. These data are reported in the form of an Exhibit A-11-44 and provide funding levels for basic research, applied research, and development, R&D support to universities and colleges and R&D facilities. Special Analysis J: Research and Development, one of the documents of the 1989 Federal budget, provides an overview of research and development in the Federal budget along with brief descriptions of the R&D programs of the larger R&D funding agencies.

The sources of data for this report are the Exhibit A-11-44s submitted by agencies to OMB, budget justification documents of the leading R&D support agencies and supplemental information provided by agency staff. The data presented in the report can be reconciled with budget authority data supplied to OMB by the agencies, but include changes made on the basis of information that was not available at the time Special Analysis J: Research and Development was prepared.

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RESEARCH AND DEVELOPMENT IN THE 1989 BUDGET

Total Research and Development

In fiscal year 1989, total budget authority for all Federal research and development programs, is expected to reach $62.9 billion, an increase of 6 percent, or $3.7 billion over the 1988 total of $59.2 billion. The overall increase in Federal R&D funding is greater than the 5 percent increase proposed for 1989 budget authority in the overall Federal budget. In 1989, support for non-defense R&D programs is expected to increase 14 percent, or $2.7 billion, compared to a much lower rate of growth for defense R&D programs--3 percent, or $1.0 billion.

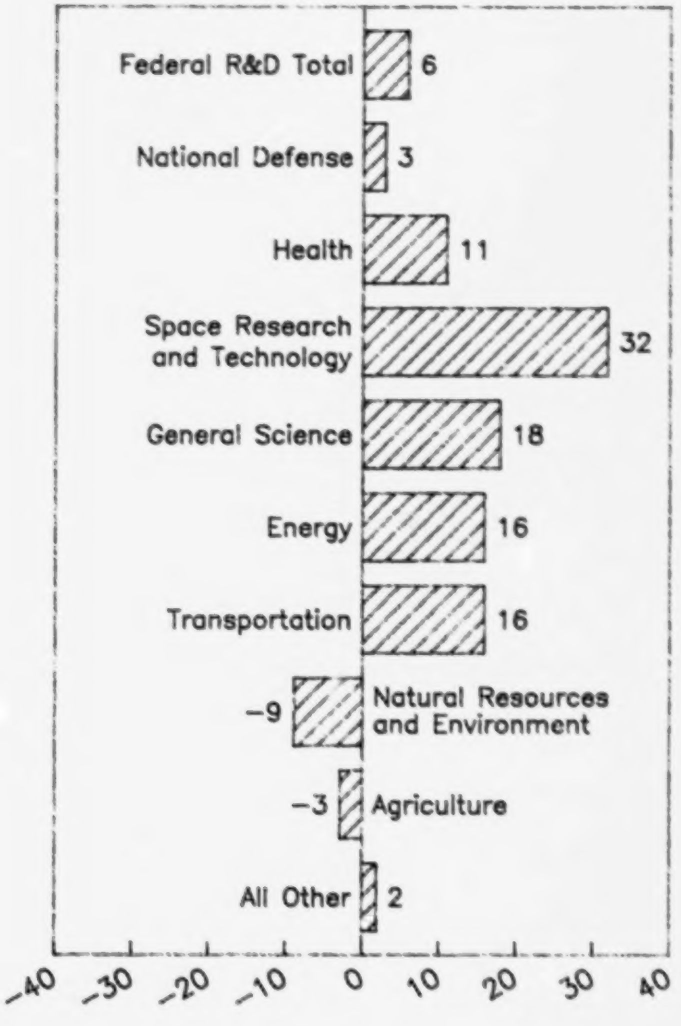
In the context of the Bipartisan Budget Agreement that places tight fiscal constraints on the overall Federal budget, the 1989 request reinforces the high priority given to research and development as being essential for the long-term economic well-being of the Nation. The Federal Government supports research and development to meet the direct needs of the Government, such as national security and regulatory activities, and broader national needs, including long-term economic growth and improving the quality of life for its citizens.

The six largest R&D budget functions--national defense, health, space research and technology, general science, energy, and transportation--all receive increased support in 1989. Significant increases are proposed for R&D activities related to: the Strategic Defense Initiative; biomedical and AIDS programs; space station development; research support by the National Science Foundation including the establishment of Science and Technology centers; initiation of the Superconducting Super Collider; and a clean coal technology demonstration program.

Budget authority for basic research across all functions is scheduled to increase 8 percent, or $795 million, to $10.3 billion in 1989. The Federal Government has traditionally played a key role in supporting basic research, since industry often lacks sufficient incentives to invest in long-term, high-risk research. This increase in basic research funding is primarily directed toward additional support for basic research at universities and colleges, which usually receive about one-half of Federal funds for basic research.

Reflecting the budgetary constraints imposed by the Bipartisan Budget Agreement, the 1989 budget continues to propose reductions for R&D programs that are no longer considered an appropriate Federal responsibility and that should be left to the States or the private sector for needed investments. These areas include reductions in or elimination of shorter-term technology development programs within the two functions of energy, and natural resources and environment.

Relative Changes for Major R&D Budget Functions: FY 1988-89



NOTE: Shown in descending order of 1989 R&D budget authority.

SOURCE: National Science Foundation

The leading factors influencing the overall growth in Federal research and development, including those creating offsetting reductions, are highlighted below in order of magnitude of the change in the size of the program:

- An increase of $1.2 billion, or 32 percent, in space research and technology R&D programs in 1989, compared with a 5-percent increase in 1988. The 1989 funding provides additional support for the Space Station and the initiation of Project Pathfinder.

- An increase of $1.0 billion, or 3 percent, for defense R&D programs in 1989, allowing for growth in the Strategic Defense Initiative and the Advanced Tactical Fighter program. The rate of increase was also 3 percent in 1988.

- An increase of $762 million, or 11 percent, in health R&D activities, following an 8-percent increase in 1988, with greater emphasis given to AIDS research and development programs.

- An increase of $383 million, or 18 percent, for general science, compared with a 5-percent gain in 1988. The 1989 increase allows for the establishment of the National Science Foundation's Science and Technology Centers and the initiation of research related to the Department of Energy's Superconducting Super Collider.

- An increase of $346 million, or 16 percent, in energy programs in 1989, following a 4-percent increase in 1988. Increases are proposed for long-term basic energy research and the implementation of the clean coal technology demonstration program.

- An increase of $146 million, or 16 percent, for transportation R&D programs, after increasing only 1 percent in 1988. The 1989 increase is primarily due to a significant increase in funding for the National Aeronautics and Space Administration's air transportation programs.

- A decrease of $102 million, or 9 percent, in natural resources and environment R&D activities, compared with a 3-percent increase in 1988.

- A decrease of $26 million, or 3 percent, for agriculture R&D programs, following a 7-percent increase in 1988.

- When combined, the remaining eight functions (each accounting for less than $500 million) will increase $23 million, or 2 percent, in 1989. The largest increases are proposed for administration of justice, and commerce and housing credit R&D programs.

Budget authority for research and development by budget function 1/
[Dollars in millions]

	1987 actual	1988 estimate	Percent change 1987/88	1989 estimate	Percent change 1988/89
Total	$57,069	$59,204	3.7%	$62,892	6.2%
National defense	39,152	40,300	2.9	41,318	2.5
Health	6,556	7,087	8.1	7,849	10.8
Space research and technology	3,398	3,574	5.2	4,733	32.4
General science	2,042	2,150	5.3	2,533	17.8
Energy	2,053	2,126	3.5	2,471	16.3
Transportation	908	918	1.1	1,064	15.9
Natural resources and environment	1,133	1,163	2.7	1,061	-8.8
Agriculture	822	876	6.6	850	-3.0
Education, training, employment, and social services	267	290	8.6	295	1.5
Veterans benefits and services	215	210	-2.3	206	-1.8
International affairs	223	208	-6.6	199	-4.3
Commerce and housing credit	110	121	9.3	131	8.4
Community and regional development	99	102	2.3	93	-9.0
Administration of justice	49	43	-12.7	55	28.8
Income security	25	20	-19.6	18	-9.0
General government	17	16	-6.0	15	-1.9

1/ Listed in descending order of 1989 R&D budget authority.

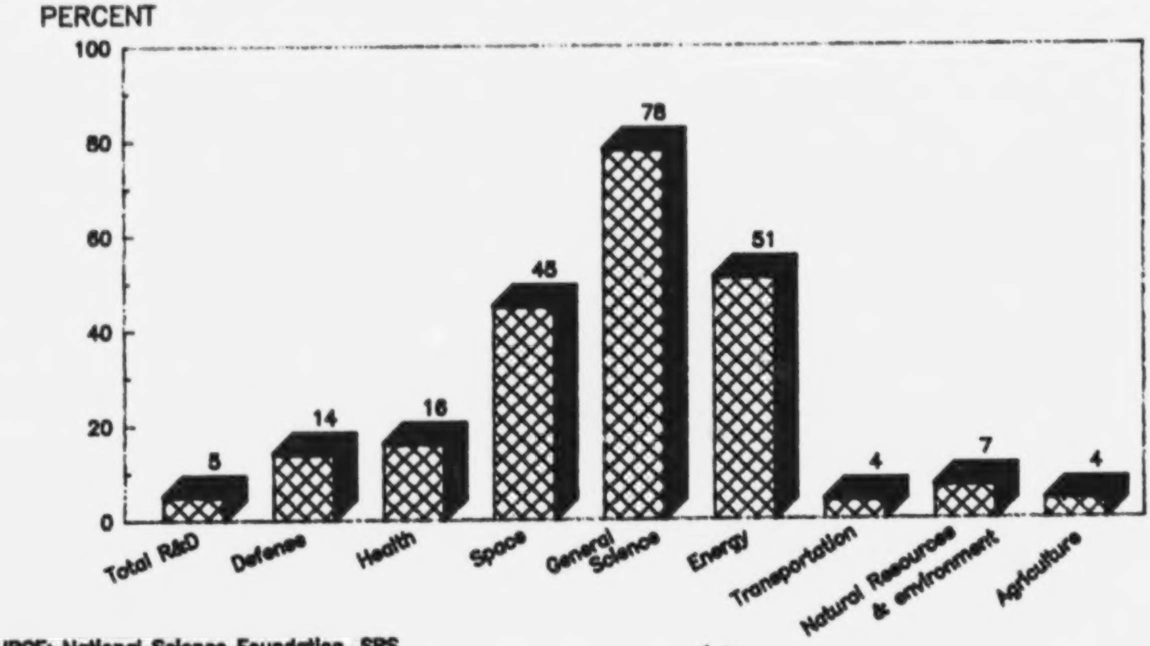
SOURCE: National Science Foundation, SRS

R&D Budget Authority as a Percent of Total Budget Authority

R&D budget authority as a percent of total Federal budget authority has remained stable over the 1987-89 period, accounting for approximately 5 percent of the total budget. Within the individual functions, research and development as a percent of the 1989 total ranges from 78 percent for general science to one-tenth of one percent for income security. Most of the activities within the general science function are considered research with the remainder consisting of R&D facilities and construction (mainly DOE) and some NSF information collection activities that are excluded from this report. On the other hand, virtually all funding for the income security function provides for benefits and assistance payments and only a fraction is devoted to R&D activities.

Over the period from 1987 to 1989, significant changes have occurred in the proportion of total Federal budget authority allocated for research and development for each of three major R&D functions. Within the space research and technology function, research and development has increased from 33 percent of total budget authority in 1987 to 45 percent in 1989. Funding for general science R&D budget authority as a percent of total budget authority has declined from 87 percent in 1987 to 78 percent in 1989. Energy research and development has fallen from 60 percent in 1987 to 51 percent in 1989.

R&D Budget Authority as a Percent of
Total Budget Authority by Major R&D Function
Fiscal Year 1989



SOURCE: National Science Foundation, SRS

Shares of Total R&D Budget Authority

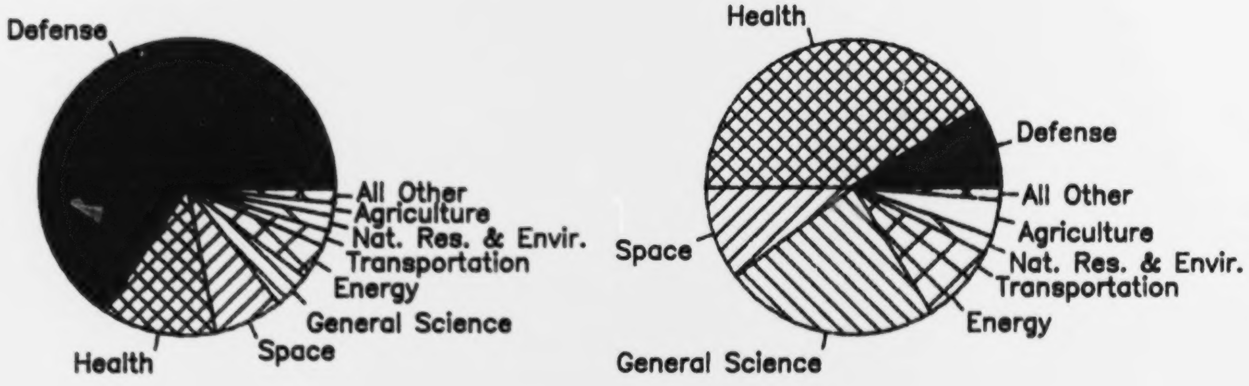
In 1989, the five leading functions--national defense, health, space research and technology, general science, and energy--account for approximately 94 percent of total R&D budget authority. Transportation and natural resources and environment each represents 2 percent, and agriculture accounts for slightly over 1 percent of the total. The remaining eight functions together account for nearly 2 percent of the R&D total.

Over the 1987-89 period, R&D priorities, measured in terms of shares of the R&D total held by various functional areas, have shifted slightly. Of the five leading functions, only the largest function--national defense--shows a decrease in percent share over the three year period.

National defense has declined from 69 percent in 1987 to 66 percent in 1989, but it remains more than five times larger than the second largest function--health. Health increased slightly from 12 percent in 1987 to 13 percent in 1989. Space research and technology, as a share of the 1989 R&D total, grew to almost 8 percent from 6 percent in 1987. During this period, general science remained stable with a 4 percent share. Energy R&D as a percent of the R&D total grew slightly to 4 percent in 1989.

Total R&D and Basic Research by Major Function

Fiscal Year 1989



Total R&D
$62.9 billion

Basic Research
$10.3 billion

SOURCE: National Science Foundation, SRS

Basic Research

Basic research continues to receive high priority in the Federal R&D budget as reflected in the 1989 request of $10.3 billion. This represents an increase of 8 percent, or $795 million, over the 1988 level of $9.6 billion. This proposed growth reflects the importance given to increased support of basic research across all scientific and engineering disciplines. The 1989 budget proposes a higher rate of growth for basic research than the overall R&D budget, which is proposed to increase 6 percent over 1988. Basic research, as a share of the R&D total, will increase slightly to almost 17 percent of the total Federal R&D budget in 1989.

The 1989 request provides for increased support for interdisciplinary research at universities and colleges not only to strengthen the ability of the nation's academic research scientists to conduct high-quality research to ensure continued technological innovation, but also to provide for the future availability of high-caliber scientists and engineers. Since the private sector often lacks sufficient incentives to invest in basic research, the Federal Government is the major supporter of the Nation's basic research effort.

The health function, accounting for 41 percent of all Federal basic research compared to 13 percent of the R&D total, is expected to increase 2 percent, or $100 million, to a total of $4.3 billion in 1989. The National Institutes of Health, within the Department of Health and Human Services (HHS), provides 93 percent of Federal health basic research and is scheduled for an increase of $110 million, or 3 percent, to $4.0 billion. Offsetting this increase are reductions in basic research funding for the Alcohol, Drug Abuse, and Mental Health Administration (HHS) of almost $10 million to $267 million in 1989. Basic research accounts for slightly more than one-half of the health R&D total.

The general science function accounts for almost one-fourth of all Federal basic research, compared to a 4-percent share of the Federal R&D total. An increase 18 percent, or $369 million, to $2.4 billion is proposed for 1989. NSF basic research programs, accounting for nearly three-quarters of the general science basic research total, are scheduled to increase 20 percent, or $290 million, to $1.7 billion. Budget authority for DOE general science basic research is $707 million, which is 13-percent, or nearly $80 million, higher than 1988. Included in the DOE general science program are funds for the Superconducting Super Collider Basic Research User Facilities program. Approximately 95 percent of the general science R&D budget supports basic research.

Basic research support within space research and technology is expected to increase 25 percent, or almost $214 million, to $1.1 billion in 1989. Space research and technology accounts for

Budget authority for basic research by function
[Dollars in millions]

	1987 actual	1988 estimate	Percent change 1987/88	1989 estimate	Percent change 1988/89
Total	$9,021	$9,530	5.6%	$10,319	8.3%
Health	3,851	4,153	7.8	4,253	2.4
General science	1,942	2,045	5.3	2,415	18.1
Space research and technology	843	849	0.7	1,062	25.2
National defense	900	907	0.9	924	1.8
Energy	511	568	11.1	571	0.5
Agriculture	397	417	5.0	418	0.3
Transportation	231	226	-2.2	329	45.5
Natural resources and environment	206	217	5.0	208	-4.1
Education, training, employment and social services	78	83	6.7	84	1.5
Commerce and housing credit	26	27	4.7	27	0.4
Veterans benefits and services	17	19	8.7	17	-8.5
Administration of justice	8	9	9.9	4	-51.7
Community and regional development	4	4	11.4	3	-17.9
General government	4	5	6.8	3	-38.3
International affairs	3	2	-21.4	1	-45.5
Income security	-	-	NA	-	NA

SOURCE: National Science Foundation, SRS

10 percent of the basic research budget and approximately 8 percent of the R&D budget. The proposed growth in 1989 is primarily due to increases in the National Aeronautics and Space Administration's space science programs. Funding for basic research comprises 22 percent of the space research and technology R&D budget.

National defense basic research funding is scheduled to increase 2 percent, or $16 million, to $924 million in 1989. Defense basic research accounts for approximately 9 percent of basic research in the 1989 budget. In contrast, 66 percent of the R&D budget is for national defense. The Department of Defense technology base program provides funding for all of the basic research support within this function. Basic research accounts for 2 percent of national defense R&D funding.

Energy basic research is scheduled to increase slightly--less than 1 percent, or $3 million--to $571 million in 1989. Energy accounts for almost 6 percent of the 1989 basic research budget and 4 percent of the R&D budget. The Department of Energy provides all of the basic research support within this function and is scheduled to increase its funding by $3 million in 1989. The Department of Energy's basic energy sciences program and the biological and environmental research program are expected to increase $22 million and $20 million, respectively. This growth is partially offset by a $27 million reduction in the petroleum, coal and gas program. Basic research accounts for almost one-fourth of the energy R&D funding.

Basic research support within the agriculture function is expected to remain relatively stable at $418 million in 1989. Agriculture as a function accounts for 4 percent of the basic research total, compared to a 1 percent share of the R&D budget. Within this function, basic research amounts to almost one-half of the R&D funding in 1989.

Transportation basic research is expected to increase almost 46 percent, or $103 million, to $329 million in 1989. Transportation accounts for 3 percent of basic research and 2 percent of research and development. All of the basic research support within this function is funded by the National Aeronautics and Space Administration's aeronautical research and technology program. In 1989, basic research accounts for 31 percent of the total R&D funding for transportation.

Natural resources and environment is scheduled to decrease 4 percent, or $9 million, to $208 million in 1989. Natural resources and environment accounts for approximately 2 percent of both the basic research and R&D totals. Support for basic research within this function comprises almost 20 percent of the R&D budget authority in 1989.

The remaining functions account for approximately 1 percent of both Federal basic research and total R&D budget authority in 1989.

NATIONAL DEFENSE

Defense R&D budget authority is proposed at $41.3 billion in 1989, representing an increase of $1.0 billion, or almost 3 percent, over the 1988 level. National defense is the largest function within the Federal R&D budget and accounts for 66 percent of the R&D total in 1989. The Department of Defense (DOD) and the Department of Energy (DOE) support the R&D programs within this function.

Although defense R&D funding is expected to increase in 1989, the 1989 request also includes reductions in selected areas. Highlights of proposed programmatic changes include:

- An increase of $1.1 billion, or 20 percent, in DOD's advanced technology development activities to a total of $6.5 billion. This level of funding provides for continued growth for the Strategic Defense Initiative.
- An increase of $881 million, or 7 percent, in DOD tactical programs to a total of $13.1 billion in 1989. The Advanced Tactical Fighter program will receive increased support.
- An increase of $234 million, or 6 percent, in DOD defensewide mission support to $4.3 billion in 1989.
- An increase of $32 million, or 1 percent, in the Department of Energy's atomic energy defense activities to $2.4 billion in 1989.
- A decrease of $886 million, or 12 percent, in DOD strategic programs to $6.5 billion in 1989. This decrease is due to a substantial reduction in funding for the Small Intercontinental Ballistic Missile (ICBM) program.
- A decrease of $412 million, or 8 percent, in DOD intelligence and communications programs to $4.5 billion.
- A slight decrease of $16 million, or less than 1 percent, in DOD technology base activities in 1988 to a total of $3.3 billion. Funding for basic research, which is included in technology base, is expected to increase 2 percent to $917 million in 1989.

R&D budget authority for national defense
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	**$39,152**	**$40,300**	**$41,318**
Department of Defense - military	36,817	37,888	38,874
Research, development, test and evaluation 1/	35,941	37,263	38,157
Tactical programs	11,032	12,212	13,093
Strategic programs	7,703	7,391	6,525
Advanced technology development	5,032	5,434	6,507
Intelligence and communications	4,702	4,882	4,470
Technology base	3,237	3,294	3,277
Defensewide mission support	4,236	4,051	4,285
Other DOD military	876	625	717
Department of Energy - atomic energy defense activities	2,335	2,412	2,444
Weapons research, development and testing	1,539	1,557	1,577
Naval reactors development	501	532	542
Materials production	123	151	143
Nuclear safeguards and security	48	63	64
Defense waste and transportation management	72	55	62
Verification and control technology	33	35	47
Program direction	19	20	9

1/ Detailed budget data for the RDT&E appropriation are only available in Total Obligational Authority (TOA).

SOURCE: National Science Foundation, SRS

Department of Defense - military

Department of Defense R&D programs, accounting for 94 percent of the national defense R&D total, are expected to increase $986 million, or 3 percent, to $38.9 billion in 1989. Virtually all of DOD's R&D programs are funded under the research, development, test, and evaluation (RDT&E) appropriation.

In 1989, funding for R&D activities within RDT&E is estimated at $38.2 billion which is $894 million, or 2 percent, higher than the 1988 level. The Defense Agencies are expected to receive the largest increase--$1.0 billion, or 13 percent over 1988. R&D activities within the Department of the Army are expected to increase $360 million, or 8 percent, in 1989. The decrease proposed for the Department of the Navy is $297 million, or 3 percent, below 1988. The Department of the Air Force, providing nearly 40 percent of RDT&E research and development funding, is scheduled for a reduction of $233 million, or approximately 2 percent, in 1989.

Within RDT&E, increases that are proposed in advanced technology development, tactical programs and defensewide mission support are partially offset by reductions in the remaining mission areas. Major R&D efforts proposed for RDT&E programs in 1989 are highlighted below by mission area.

Tactical programs, accounting for one-third of DOD R&D funding, are scheduled to increase $881 million, or 7 percent, to $13.1 billion in 1989. These programs provide for the development of systems that will enhance the capabilities of U.S. general purpose and nuclear theater forces.

The Department of the Navy R&D budget, accounting for almost one-half of tactical programs funding, allows for a major effort to improve air, surface and submarine-based anti-submarine warfare capabilities, including development of the Seawolf attack submarine. R&D activities will continue on the V-22 Osprey tilt-rotor aircraft, the Advanced Tactical Aircraft and upgrades to the F-14 fighter aircraft.

The Department of the Air Force programs include continued development of the Joint STARS radar, the Advanced Tactical Fighter aircraft and the C-17 transport aircraft, as well as various electronic warfare programs. Efforts will also continue on munitions used against hardened targets, development of TR-1 surveillance aircraft sensors and ground stations, and improvements to the AWACS radar system.

Department of the Army funding will provide for continued development of advanced anti-tank weapons systems, cannon-fired precision munitions, and ground-based missiles and control systems for air defense.

R&D obligational authority for Research, Development, Test and Evaluation (DOD) 1/
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$35,941	$37,263	$38,157
AGENCY TOTALS			
Department of the Air Force	15,051	15,165	14,932
Department of the Navy	9,292	9,513	9,216
Defense Agencies	6,768	7,662	8,668
Department of the Army	4,699	4,671	5,031
Tactical programs	11,032	12,212	13,093
Department of the Navy	5,174	5,663	5,992
Department of the Air Force	3,631	4,031	4,266
Department of the Army	1,971	2,295	2,653
Defense Agencies	256	223	181
Strategic programs	7,703	7,391	6,525
Department of the Air Force	5,593	5,887	5,359
Department of the Navy	1,813	1,252	781
Defense Agencies	70	133	305
Department of the Army	227	119	80
Advanced technology development	5,032	5,434	6,507
Defense Agencies	3,768	4,092	5,145
Department of the Air Force	688	755	784
Department of the Army	433	354	374
Department of the Navy	144	233	204
Intelligence and communications	4,702	4,882	4,470
Department of the Air Force	2,293	2,132	2,026
Defense Agencies	1,688	1,729	1,640
Department of the Navy	626	914	752
Department of the Army	95	108	52
Technology base	3,237	3,294	3,277
Defense Agencies	812	1,071	970
Department of the Air Force	783	755	783
Department of the Navy	785	750	773
Department of the Army	857	718	752
Defensewide mission support	4,236	4,051	4,285
Department of the Air Force	2,063	1,605	1,715
Department of the Army	1,116	1,078	1,119
Defense Agencies	306	668	737
Department of the Navy	751	701	714

1/ Detailed budget data for the RDT&E appropriation are only available in Total Obligational Authority (TOA).

SOURCE: National Science Foundation, SRS

Strategic programs are expected to decrease $886 million, or 12 percent, to $6.5 billion in 1989. This decline is primarily the result of a substantial reduction in R&D funding for the Small Intercontinental Ballistic Missile (ICBM), pending further review of the program. The Department of the Air Force accounts for over three-quarters of the strategic programs R&D budget. The 1989 request for strategic programs allows for funding of the air-launched short-range attack missile, the B-2 Advanced Technology Bomber, the Advanced Cruise Missile, and the MILSTAR communications satellite program. Developmental activities on the Trident II submarine-launched ballistic missile and the Peacekeeper missile are nearing completion. The 1989 request also provides funding for ICBM modernization and the rail garrison basing mode for the Peacekeeper.

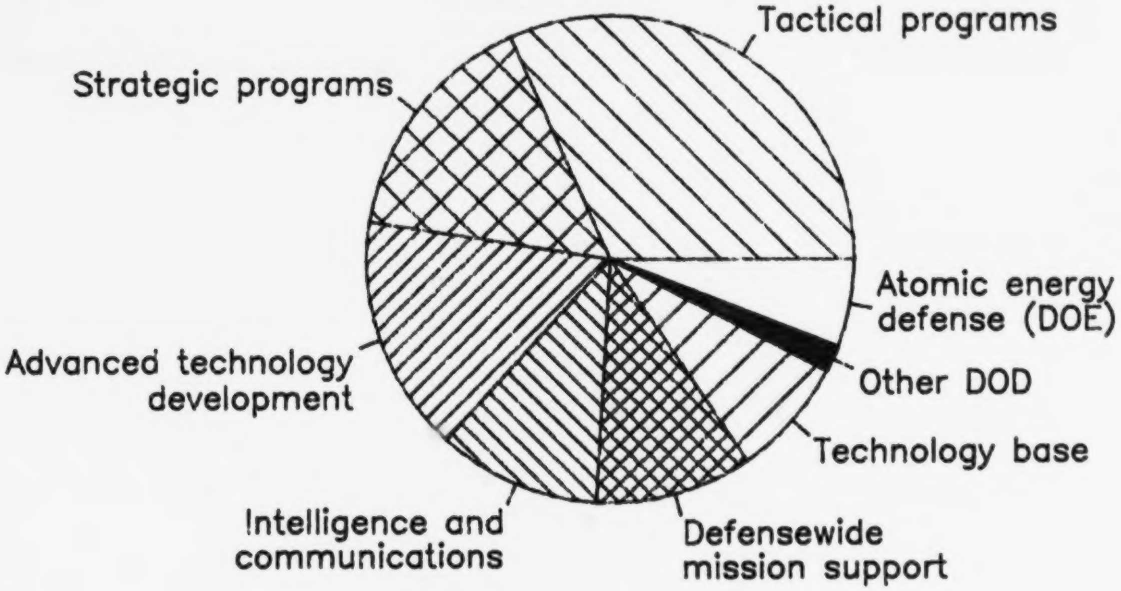
Advanced technology development is scheduled to increase $1.1 billion, or 20 percent, to $6.5 billion in 1989. This increase, the largest within the DOD mission areas, is primarily the result of the high priority placed on the Strategic Defense Initiative (SDI). This initiative, designed to investigate the feasibility of defense against ballistic missiles, includes research on space surveillance and target acquisition, directed energy weapons, kinetic energy weapons, battle management systems and systems survivability. SDI R&D activities, funded through the Strategic Defense Initiative Organization (SDIO) defense agency, is scheduled to receive a 28-percent increase in 1989 to $4.5 billion. The Defense Agencies provide 79 percent of advanced technology development funding in 1989.

In addition, the advanced technology development budget provides increased funding of defense-related R&D activities supporting the transatmospheric National Aerospace Plane in conjunction with the National Aeronautics and Space Administration. Department of the Air Force funding for the National Aerospace Plane is expected to increase 34 percent to $245 million in 1989. Continued emphasis is placed on materials research and electronics, including development of state-of-the-art integrated circuits, specifically, the Very High Speed Integrated Circuits (VHSIC) program and the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) program. DOD support for SEMATECH, a private sector consortium formed to maintain world-class semiconductor manufacturing capabilities in the U.S., is also funded through the advanced technology development program.

Intelligence and communications programs are proposed for a reduction of $412 million, or 8 percent, below the 1988 level to a total of $4.5 billion in 1989. R&D activities are directed toward improving defense intelligence systems, and command control and communications programs. Efforts include improving threat warning and surveillance sensors through the use of advance signal processing technology, and continued work on satellite communications, surveillance radars, thermal imagers, and infrared search and track systems.

Technology base programs are estimated at $3.3 billion in 1989, which is $16 million, or less than 1 percent, below the 1988 level. Basic research support within DOD, funded within the technology base programs, is expected to increase $15 million, or 2 percent, to $917 million in 1989. Basic research accounts for 28 percent of technology base funding. These programs support fundamental investigations of processes and phenomena in disciplines involving technologies with potential military applications.

Defensewide mission support is expected to increase $234 million, or 6 percent, to $4.3 billion in 1989. In addition to providing support for ranges and test facilities, this program also supports R&D activities related to improving test and evaluation capabilities. R&D activities will continue in areas such as using technology to reduce manufacturing costs, and to extend the life and capabilities of existing defense systems.



National Defense R&D by Activity

Fiscal Year 1989

Total Defense R&D
$41.3 billion

SOURCE: National Science Foundation, SRS

Department of Energy - atomic energy defense activities

R&D funds for atomic energy defense activities within DOE are proposed at $2.4 billion in 1989. This represents an increase of $32 million, or 1 percent, over the 1988 level. Atomic energy defense activities account for 6 percent of national defense R&D budget authority in 1989.

Weapons research, development and testing accounts for 65 percent of the atomic energy defense activity with $1.6 billion in 1989. This proposed level represents an increase of 1 percent, or $20 million, over 1988. Funding for 1989 provides continued support for designing, testing, and certifying new weapons; advancing state-of-the-art weapons technology; and monitoring the nuclear weapons stockpile to assure continued reliability and effectiveness. The Nuclear Directed Energy Weapons (NDEW) program, supporting the Strategic Defense Initiative, and the Inertial Fusion Research program will both be funded at levels comparable to 1988.

The naval reactors development program will receive an estimated $542 million, or almost one-quarter, of the atomic energy defense activity funding. This proposed funding reflects an increase of $11 million, or 2 percent, over 1988. The naval reactors development program supports nuclear propulsion development work which provides the U.S. Navy with ships having virtually unlimited high speed endurance. In 1989, work will continue on improving existing submarine and surface ship reactors and plant components, and developing advanced reactor concepts and propulsion plants. The Advanced Fleet Reactor, which will provide enhanced performance for a new generation of nuclear-powered attack submarines, remains a priority effort.

Materials production is scheduled to decrease 5 percent, or $8 million, to $143 million in 1989. Despite this reduction, long-term efforts to develop a new production reactor are being continued to guarantee a continuous supply of tritium for the nuclear weapons stockpile. R&D funding for nuclear safeguards and security is proposed at $64 million--increasing 2 percent, or $1 million, over 1988. Defense waste and transportation management, will receive a proposed increase of 13 percent, or $7 million, to $62 million in 1989. R&D efforts will proceed in developing safe storage and disposal methods for radioactive waste resulting from weapons production.

Verification and control technology is expected to increase 33 percent, or almost $12 million, to $47 million. Detection technology efforts within this activity include research and development of seismic, nonseismic and satellite devices for verification of nuclear-related arms control treaties. The proposed growth in this program is largely due to increased emphasis given to R&D efforts related to the ratification of earlier test ban treaties and other arms control negotiations.

HEALTH

The proposed budget authority for health research and development is $7.8 billion in 1989, an increase of $762 million, or 11 percent, over the 1988 level. R&D activities within the health function fall under two broad categories, health and consumer and occupational health and safety. All of these activities are supported by the Department of Health and Human Services with the exception of the Occupational Safety and Health Administration within the Department of Labor.

In 1989, all Public Health Service (PHS) funding for Acquired Immune Deficiency Syndrome (AIDS) is being requested in a consolidated appropriation within the Office of the Assistant Secretary for Health (OASH). In 1987 and 1988, AIDS activities were supported through funds appropriated directly to the PHS agencies. This consolidated appropriation is intended to improve coordination, flexibility, and visibility of the resources devoted to AIDS. Operational responsibilities will continue to reside within the individual PHS agencies.

The analysis of the National Institutes of Health and the Alcohol, Drug Abuse, and Mental Health Administration includes an examination of both AIDS and non-AIDS R&D programs. The discussion of non-AIDS R&D programs uses funding levels for 1988 that exclude AIDS support, referred to as "comparable level."

Notable features of the proposed 1989 R&D health function include the following:

- In 1989, R&D budget authority for health-related programs is proposed to increase by 11 percent, or $765 million, to 7.8 billion.
    - R&D budget authority for the National Institutes of Health is expected to be $6.2 billion in 1989, a 6-percent, or $357 million, increase over the 1988 comparable level.
    - A total of $900 million of the AIDS consolidated appropriation is proposed for R&D activities, representing a 42-percent, or $264 million, increase over the amount appropriated directly to the PHS agencies for AIDS in 1988.
    - The Alcohol, Drug Abuse, and Mental Health Administration's R&D funding in 1989 is $522 million, a 5-percent, or $25 million, increase over the 1988 comparable level.
- R&D budget authority for consumer and occupational health and safety programs is expected to decline 2 percent, or $2 million, to $93 million.

R&D budget authority for health
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$6,556	$7,087	$7,849
Health programs (HHS)	6,466	6,991	7,756
National Institutes of Health	5,852	6,320	6,229
Acquired Immune Deficiency Syndrome 1/	-	-	900
Alcohol, Drug Abuse, and Mental Health Administration	509	558	522
Centers for Disease Control	65	72	63
Assistant Secretary for Health	20	21	20
Health Care Financing Administration	10	10	11
Health Resources and Services Administration	10	11	11
Consumer and occupational health and safety	90	95	93
Food and Drug Administration (HHS)	85	91	88
Occupational Safety and Health Administration (Labor)	5	4	5

1/ In 1987 and 1988, AIDS activities were supported through funds appropriated directly to the Public Health Service agencies.

Source: National Science Foundation, SRS

Health programs

R&D budget authority for health-related programs is proposed at $7.8 billion in 1989. This represents an increase of 11 percent, or $765 million, over 1988. Health-related programs account for 99 percent of the R&D funding within the health function.

Beginning in 1989, funding for AIDS is proposed to be consolidated within a new appropriation under the Office of the Assistant Secretary for Health. In 1987 and 1988, AIDS activities were supported through funds appropriated directly to selected Public Health Service agencies. The PHS agencies supporting AIDS R&D activities include: the National Institutes for Health, the Alcohol, Drug Abuse, and Mental Health Administration, the Centers for Disease Control, the Office of the Assistant Secretary for Health, the Health Care Financing Administration, and the Food and Drug Administration (within consumer and occupational health and safety programs).

National Institutes of Health (HHS)

In 1989, the proposed R&D budget authority for the National Institutes of Health (NIH) is $6.2 billion, an increase of 6 percent, or $357 million, above the 1988 comparable level. NIH, which comprises 80 percent of health R&D funding, conducts and supports biomedical and behavioral research and development on the prevention, diagnosis, and treatment of disease.

Among all R&D activities at NIH, investigator-initiated research is given highest priority. The proposed 1989 budget request supports 20,600 research project grants, 837 more awards than the 1988 comparable level, and a record high number of awards for NIH. This total number of research project grants is comprised of 15,000 noncompeting continuation grants and 5,600 competing awards. This represents an increase of 1,091 in the number of noncompeting awards, but 254 fewer competing awards than in 1988. Proposed funding for research project grants totals $3.9 billion, which yields an increase in the average amount of an award by 5 percent for noncompeting awards and by 3 percent for competing awards. In addition, the 1989 request includes $539 million to support 555 research centers, four fewer than in 1988.

The NIH portion of the consolidated appropriation for AIDS-related research and development is $588 million in 1989. This represents a $120 million, or 26-percent, increase over the 1988 level. NIH's AIDS program provides a multi-faceted and integrated approach, emphasizing multidisciplinary research, and involving 16 of the 18 NIH components. However, most of this R&D effort is concentrated within the National Institute for Allergy and Infectious Diseases, with 53 percent of NIH-designated funds, and the National Cancer Institute, with 21 percent. The majority of NIH-supported AIDS activities will be funded through research project grants and multidisciplinary centers established in 1988.

R&D budget authority for the National Institutes of Health (HHS)[1]

[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$5,842	$6,320	$6,229
National Cancer Institute	1,364	1,436	1,435
National Heart, Lung, and Blood Institute	887	924	973
National Institute of General Medical Sciences	505	565	610
National Institute of Neurological and Communicative Disorders and Stroke	476	520	543
National Institute of Diabetes and Digestive and Kidney Diseases	489	513	540
National Institute of Allergy and Infectious Diseases	534	626	422
National Institute of Child Health and Development	351	381	382
Division of Research Resources	322	366	318
National Eye Institute	209	219	223
National Institute of Environmental Health Sciences	200	206	209
National Institute on Aging	170	186	196
National Institute of Arthritis and Musculoskeletal and Skin Diseases	132	142	152
National Institute of Dental Research	113	121	122
Office of the Director	52	57	48
National Library of Medicine	19	22	23
National Center for Nursing Research	18	21	21
John E. Fogarty International Center	11	16	11

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[1] In 1989, R&D funding for AIDS is included in the consolidated AIDS appropriation within OASH.

Source: National Science Foundation, SRS

The proposed R&D budget authority for the National Cancer Institute (NCI) is $1.4 billion in 1989, 7-percent, or $88 million, more than the 1988 comparable level. This growth is attributable largely to a $77 million increase to $739 million for project research grants, providing support for a total of 3,281 grants, 219 more than the 1988 comparable level. NCI has a dual mandate to conduct basic research, which accounts for about one-half of its R&D funding, and to apply research results to decreasing the incidence of cancer morbidity and mortality. R&D efforts are directed at preclinical and clinical treatment research, diagnostic research, tumor biology, physical, chemical, and biological carcinogenesis, immunology, and epidemiology.

About $125 million of the consolidated appropriation has been designated for AIDS-related R&D activities within NCI in 1989. This provides a $35 million increase over the amount directly appropriated to NCI in 1988. This growth will enable an expansion of the Preclinical Screening Program to increase the current annual capacity for screening compounds with anti-retroviral activity. The intramural clinical trials program will be augmented to accommodate the need for increased treatment of drug and biological agents being developed and expansion of the clinical protocols for AIDS patient treatment is anticipated to enable testing of new viral-toxic drugs and drug compounds. Work on the characterization of the new HBLV virus will be continued.

The National Heart, Lung, and Blood Institute (NHLBI), is anticipated to receive $973 million for R&D activities in 1989. This represents an increase by $74 million, or 8 percent, over the 1988 comparable level. Research project grants are expected to receive $671 million of these funds, up $69 million from 1988. This will support a total of 3,038 research grants, 199 more than the 1988 comparable level. In the aggregate, other extramural programs are proposed to remain at approximately 1988 levels. NHLBI conducts and supports R&D programs that include basic investigations, clinical trials, educational programs related to the cause, diagnosis, treatment, and prevention of heart, lung, blood vessel and blood diseases.

About $39 million of the consolidated appropriation for AIDS-related activities will support the NHLBI program, a 58-percent increase over the 1988 level. AIDS R&D activities within NIHLBI are concerned with the development of blood tests to detect the presence of the AIDS virus, of methods to inactivate it, and of preparations that may be useful in the prevention of AIDS in people known to be infected with the virus. The 1989 request will support new epidemiological studies on human retroviruses and continued planning and evaluation of pulmonary and cardiac involvement of HIV-infected children with AIDS.

R&D funding for the National Institute of General Medical Sciences (NIGMS) is expected to increase by 10 percent, or $53 million, over the 1988 comparable level, to $610 million in 1989. The increase is due largely to an 8-percent increase to $574 million for research project grants. The 1989 request will support 3,383 research project grants, a net increase of 145 over the 1988 comparable level. All other research mechanisms are expected to remain at 1988 levels. NIGMS R&D programs, primarily basic research, focus on the relationship of structure to function in biological systems, such as the understanding of protein folding, the relationship between genetic makeup and diseases, and the impact of membrane structure on the immune system.

In 1989, NIGMS is expected to receive $11 million of the AIDS consolidated appropriation. R&D funding will continue support for research on structural biology, and the production and distribution of reverse transcriptase and other hard-to-obtain proteins needed for the completion of ongoing studies.

Budget authority for R&D activities within the National Institute of Allergy and Infectious Diseases (NIAID) is $422 million, a increase of 5 percent, or $20 million, over the 1988 comparable level. Most of this growth is due to a $16 million increase to $304 million for research project grants, which will support 1,745 awards, 23 more than the 1988 comparable level. Other funding mechanisms will remain level with or increase slightly over 1988 comparable totals. NIAID R&D activities, 64 percent of which are basic research, include basic and clinical research on infectious diseases and diseases associated with disorders of the immune system.

NIAID is expected to receive $310 million, over one-third of the consolidated appropriation, to support its AIDS R&D activities in 1989. With over one-half of the NIH share of AIDS R&D funds, NIAID has the largest AIDS program of any NIH component. The 1989 proposed funding is $87 million, or 39 percent, more than the 1988 comparable level. The extramural research program on AIDS focuses on the epidemiology and natural history of the disease; the pathogenesis of HIV infection; development and clinical testing of antiviral agents against HIV; of agents and procedures for reconstitution of the immune system, and for the treatment of the opportunistic infections that kill infected persons; and the development and clinical testing of candidate vaccines for the prevention of HIV infection. Intramural research continues to support research on the immunopathogenesis of the disease, to evaluate candidate therapies, and to develop candidate AIDS vaccines.

The 1989 budget request proposes increases over the 1988 comparable level for all other NIH components. The National Institute of Neurological and Communicative Disorders and Stroke is estimated to increase 7 percent over the 1988 comparable level to $542 million and the National Intitute of Diabetes and Digestive and Kidney Diseases, 6 percent to $540 million.

Alcohol, Drug Abuse, and Mental Health Administration (HHS)

The 1989 R&D budget request is $522 million for the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA) an increase of $25 million, or 5 percent, over the 1988 comparable level. ADAMHA conducts research on the causes, prevention, and treatment of alcohol and drug abuse, and on mental disease and neurological disorders with emphasis given to the improvement of the effective prevention of these public health problems. In 1989, the highest priority will be given to research project grants, which will support 1,654 grants, a modest increase over the 1988 comparable level. Research project grants will emphasize R&D efforts related to the coverage, organization, and delivery of health care. ADAMHA will expand its R&D activities to address the needs of the homeless, and continue the President's 1987 Anti-drug Initiative.

ADAMHA is scheduled to receive $82 million of the consolidated appropriation for R&D activities on AIDS in 1989. This represents an increase of 34 percent, or $21 million, above the amount appropriated directly to ADAMHA in 1988. The request will support a broad range of basic and applied research and demonstration projects, and grants to expand treatment capacity. Focus will be placed on HIV's effects on the brain and nervous system.

R&D budget authority for the National Institute of Mental Health (NIMH) is expected to total $272 million in 1989, 7 percent, or $18 million, over the 1988 comparable level. NIMH conducts and supports research on behavioral, clinical, applied, psychopharmacological, and epidemiological research, rape services development, and crime and delinquency. In 1989, NIMH will support 955 research project grants, 40 more than in 1988, and 28 research centers. The agency will emphasize basic research in the neurosciences, and continue current efforts on prevention, treatment, and epidemiology.

R&D activities within the National Institute for Drug Abuse (NIDA) is expected to receive $104 million in 1989, 4-percent, or $4 million below the 1988 comparable level. The NIDA is the lead Federal agency and the predominant national source of funding for research on drug abuse. NIDA sponsors and conducts a wide variety of research on the causes and consequences of drug abuse and collects information on its incidence. Priority will be placed on treatment and prevention of drug abuse and on cocaine. The decrease in R&D funding in 1989 will support 371 research project grants, 53 less than the 1988 comparable level. R&D funding for research centers and intramural funding are anticipated to increase slightly over 1988.

The proposed R&D budget authority for the National Institute on Alcohol Abuse and Alcoholism (NIAAA) is $83 million in 1989, almost $9 million, or 12 percent, over the 1988 comparable level. Areas of emphasis in alcohol research include research on genetic factors related to alcoholism, treatment assessment research, and

R&D budget authority for the Alcohol, Drug Abuse, and Mental Health Administration (HHS)1/
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$509	$558	$522
National Institute of Mental Health	247	280	272
Extramural research	185	212	206
Basic studies in brain and behavior	56	62	67
Schizophrenic disorders	22	26	28
Depression and manic depressive illnesses	20	20	22
Childhood disorders	13	15	16
Mental disorders of aging	12	13	14
Anxiety disorders	10	10	11
Epidemiology	10	10	11
Biometric and clinical applications	8	10	11
Antisocial and violent behavior	9	8	9
Prevention	7	7	7
Behavioral medicine and stress	5	5	6
Minority research resources	4	4	4
Acquired Immune Deficiency Syndrome	9	21	-
Intramural research	62	67	65
National Institute of Drug Abuse	124	131	104
Extramural research	111	118	91
Multiple/non-specific substances	33	30	28
Cocaine and stimulants	14	17	17
Heroin and narcotics	17	17	16
Endogenous substances	10	10	9
Marijuana and cannabinoids	8	8	7
Sedatives and tranquilizers	4	5	5
Nicotine	5	5	4
Hallucinogens	4	4	4
Inhalants	1	2	2
Acquired Immune Deficiency Syndrome	16	21	-
Intramural research	12	13	12
National Institute on Alcohol Abuse and Alcoholism	71	79	83
Program support	67	69	63

1/ In 1989, R&D funding for AIDS is included in the consolidated AIDS appropriation within OASH.

Source: National Science Foundation, SRS

research in the neurosciences. The causes and consequences of alcohol use, particularly among teenagers, will also be addressed. The proposed 1989 budget will provide 20 more research project grants than the 1988 comparable level, for a total of 328, and a 5-percent increase in intramural research funds.

Other Health Research

The proposed R&D budget in 1989 for the Centers for Disease Control (CDC) is $63 million, a decrease of $10 million, or 13 percent, from 1988. CDC conducts research on disease prevention and risk reduction on sexually transmitted diseases, immunization, infectious diseases, chronic and environmental diseases, and occupational safety and health.

The proposed R&D budget authority for the Office of the Assistant Secretary for Health (OASH) is $20 million in 1989, a decrease of 1 million from 1988. The decrease is due mainly to an expected reduction in R&D support for the National Center for Health Research and Health Care Technology. OASH conducts and supports research on the organization, financing, and delivery of health services and the understanding of the issues surrounding adolescent pregnancy.

Funding for R&D activities within the Health Care Financing Administration (HCFA), expected to receive $11 million in 1989, supports research on alternate payment systems, quality of care, physician and hospital payment, program efficiencies, beneficiary awareness and prevention, subacute and long-term care.

The primary focus of the Health Resources and Services Administration (HRSA) R&D program, scheduled to receive $11 million in 1989, is to improve the quality, effectiveness, and efficiency of services for mothers, children, and disabled children through the identification of methods for improving and delivering services.

Consumer and Occupational Health and Safety programs

The $88 million in R&D budget authority proposed in 1989 for the Food and Drug Administration (FDA) reflects a $3 million, or 3-percent, decrease from 1988. The FDA supports research relevant to its mission of regulating food, drugs, biologics, medical devices and radiological products. The FDA is one of the PHS agencies conducting AIDS research and development.

The Occupational Safety and Health Administration (OSHA) is estimated to increase by 5 percent to $5 million in 1989. OSHA is responsible for research for the purposes of setting priorities and agendas for the completion and revision of standards, and the development of an effective enforcement program. OSHA conducts evaluations of the environmental impact of all proposed standards, in addition to regulatory analyses of new OSHA standards.

SPACE

R&D budget authority for space research and technology is proposed at a total of $4.7 billion in 1989. This represents a 32-percent, or $1.2 billion, increase over the 1988 level. The National Aeronautics and Space Administration (NASA) provides all the funding for research and development conducted within this function. NASA's R&D programs reflect the priorities set by the Administration's recently approved National Space Policy to reaffirm the U.S. commitment to leadership in space-related endeavors.

NASA's R&D investment seeks to provide a permanent U.S. presence in space with a manned Space Station; to support the Shuttle-based space transportation system; to advance knowledge of the earth, the near-earth environment, the solar system and the universe; and to support long-term research and technology advancement.

The 1989 request provides increases in all but one NASA R&D program. The following highlights the major program emphases requested in the 1989 budget:

- A 52-percent, or $603 million, increase to $1.8 billion is proposed for the space transportation systems (STS) program.
    - Within the STS program, funding for the Space Station is expected to more than double from $306 million to $767 million in 1989, to support full-scale hardware development.
    - An increase of $123 million over the 1988 level to $607 million is scheduled for the STS capability development program.
- A 28-percent, or $334 million, increase over 1988 is expected for the space science program.
    - Within the space science program, R&D funding for physics and astronomy is expected to increase by 35 percent, or $204 million, to $792 million in 1989.
- A 58 percent, or $196 million, increase to $531 million in 1989 is proposed in the space research and technology program.
    - Within the space research and technology program, $98 million is proposed in 1989 to begin a new initiative called Project Pathfinder.

R&D budget authority for space research and technology
(Dollars in millions)

	1987 actual	1988 estimate	1989 estimate
Total	$3,398	$3,574	$4,733
National Aeronautics and Space Administration			
Space transportation systems	1,126	1,163	1,766
Space science	1,167	1,210	1,544
Space and terrestrial applications	675	703	714
Space research and technology	306	335	531
Commercial programs and technology utilization	56	88	75
Transatmospheric research and technology	26	32	50
Safety reliability and quality assurance	23	21	31
Space tracking and data advanced systems	20	21	23

SOURCE: National Science Foundation, SRS

Space Transportation Systems

In 1989, the proposed R&D budget authority for space transportation systems is $1.8 billion, an increase of $603 million, or 52 percent, over 1988. STS, which includes the Space Station and STS capability development, is NASA's largest R&D program, accounting for 37 percent of its total R&D funding.

Budget authority for R&D programs related to the Space Station is expected to increase from $306 million in 1988 to $767 million in 1989. The Space Station features pressurized laboratories, accommodations for attached payloads, and free-flying unmanned platforms. The pressurized habitation and laboratory modules enable a diverse array of scientific activities to be conducted under microgravitional conditions. The overall growth reflects the resources necessary to begin the full-scale development phase of the Space Station, which is scheduled for a 1994 launch. The 1989 request includes $20 million for the Flight Telerobotics Servicer (FTS), a highly automated telerobotic device that will be operated by astronauts to assist in the assembly and servicing of the Space Station. The transition definition program is expected to receive $12 in 1989, to support planning and development activities for the future operations of the station.

Budget authority for the capability development program is expected to increase by 25 percent, or $123 million, to $607 million in 1989. The space transportation capability program is concerned with the development and use of capabilities related to the Space Shuttle, including such projects as the Tethered Satellite System, the Orbital Maneuvering Vehicle (OMV), and Spacelab systems. The 1989 budget request provides an increase of 14 percent, or $18 million, to $141 million in 1989 for the development of the upper stages, which are required to deploy payloads to orbits and trajectories not otherwise obtainable.

The engineering and technology base, which is proposed to increase by 44 percent, or $47 million, to $153 million in 1989, provides core scientific, engineering, and technical resources at NASA's space centers and laboratories. The Orbital Maneuvering Vehicle, expected to increase by $56 million to $93 million in 1989, will provide a reusable, remotely operated propulsion vehicle capable of payload delivery, retrieval, and servicing that is beyond the reach of the Space Station or the Space Shuttle. Spacelab, expected to increase by 46 percent to $77 million in 1989 for development and operations activities, is a joint NASA/European Space Agency (ESA) effort that will provide a versatile, reusable laboratory to be flown to and from earth orbit in the orbiter cargo bay. R&D funding is scheduled to increase more than two-fold to $23 million in 1989 for the Tethered Satellite System (TSS), a collaborative effort between Italy and the U.S. to provide a reusable capability for conducting space experiments in regions remote to the Shuttle orbiter.

R&D budget authority for space transportation systems
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$1,126	$1,163	$1,766
Space Station program	376	306	767
Development	103	280	735
Flight telerobotic system	20	22	20
Transition definition	-	4	12
Definition	250	-	-
Crew emergency return vehicle	3	-	-
Capability development program	456	484	607
Upper stages	145	123	141
Engineering and technology base	124	106	153
Orbital Maneuvering Vehicle (OMV)	42	37	93
Spacelab	67	53	77
Payload operations & support equipment	38	67	65
Advanced programs	31	37	43
Tethered Satellite System (TSS)	10	10	23
Advanced launch systems	-	52	13
Research and program management	293	373	392

SOURCE: National Science Foundation, SRS

Space science

The R&D budget authority proposed for space science is $1.5 billion in 1989, a $334 million, or 28-percent, increase over 1988. In 1989, the space science program, which comprises about one-third of the total R&D budget authority for space, will support a major new flight project and the augmentation of several programs. It uses a variety of space systems, supported by ground-based and airborne observations to conduct a broad spectrum of scientific investigations of the earth, its space environment, the Sun, the planets, the stars of our galaxy, and the universe.

Funding for R&D activities within the physics and astronomy program is expected to increase 35 percent, or $203 million, over 1988 to $792 million in 1989. The program consists of a combination of large free-flying space missions, Explorer spacecraft, Shuttle/Spacelab flights, and suborbital vehicles to study the universe, the fundamental laws of physics, and the formation of stars and planets.

The 1989 request will support an increase in funding for R&D activities in all but two physics and astronomy programs. R&D funding will be directed toward the continued development of two major flight projects, the Hubble Space Telescope and the Global Geospace Science (GGS) program. The Hubble Space Telescope, proposed to increase by 14 percent to $102 million, is scheduled for a 1989 Shuttle launch and will serve as a major astronomy facility for a 10 to 15 year period. The Global Geospace Science program, which is expected to increase by $81 million to $101 million in 1989, is a multi-spacecraft, international science mission that will study the interaction between the Sun and the earth.

The 1989 R&D budget request includes a 26-percent increase to $82 million to support the augmentation of the Explorer program. This increase enables the development of several-low cost free-flying payloads in the Explorer tradition, and an expansion of the Scout-class expendable launch vehicles for fast-turnaround scientific space missions. Several Spacelab astronomy experiments are being planned within the Shuttle/Spacelab payload/mission management and integration program, which is scheduled to increase 18 percent to $62 million. The proposed R&D budget authority provides $45 million for the suborbital program to conduct near-earth experiments using balloon, Spartan, and sounding rockets. The Gamma Ray Observatory, planned for launch in 1990, is expected to receive $42 million in 1989. This observatory will enhance basic research in high energy astrophysics and provide new knowledge about the origin of the universe.

An additional $27 million in R&D funding is proposed in 1989 to begin a major new R&D initiative, the Advanced X-Ray Astrophysics Facility (AXAF). The AXAF will provide a space-based telescope for viewing the x-ray portion of the spectrum at 1000 times more capability than previously available.

R&D budget authority for space science
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$1,167	$1,210	$1,544
Physics and astronomy 1/	553	588	792
Mission operations and data analysis	131	127	156
Hubble Space Telescope development	96	90	102
Global geospace science (GGS)	-	20	101
Research and analysis	53	80	89
Explorer development	56	65	82
Payload and instrument development	-	42	77
Shuttle/Spacelab payload/mission management and integration	73	52	62
Suborbital program	79	43	45
Gamma Ray Observatory (GRO) development	50	51	42
Advanced x-ray astrophysics facility development (AXAF)	-	-	27
Space station integrated planning and attached payloads	15	18	8
Planetary exploration	349	322	400
Mission operations and data analysis	73	73	112
Research and analysis	68	66	83
Magellan (Venus Radar Mapper)	95	71	34
Galileo development	69	51	61
Mars observer (MGCO)	35	53	101
Ulysses (ISPM)	10	8	10
Life sciences	71	69	102
Research and analysis	41	38	47
Life sciences flight experiments	30	31	55
Research and program management	194	231	251

1/ As of 1988, program budgets reflect transfers resulting from the reorganization of the Office of Space Science and Applications.

SOURCE: National Science Foundation, SRS

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The planetary exploration program shows an increase of 24 percent to $400 million in R&D support in 1989. This program includes explorations of the earth-like inner planets, the giant, gaseous outer planets, and the small bodies such as comets and asteroids. The $112 million proposed for mission operations and analysis will support development activities of the Magellan mission and analysis of the data being relayed back from the Pioneer and Voyager missions. R&D funding for the Mars Observer is proposed to nearly double to $101 million in 1989 to permit completion of the spacecraft and instrument designs in preparation for a 1992 launch.

R&D budget authority shows an increase of $10 million to $61 million for the Galileo orbiter and probe mission to Jupiter. Galileo is scheduled for a 1992 launch and will explore the planet's atmosphere, magnetosphere and satellites. The Magellan mission to map the planet Venus is proposed to decrease by 53 percent to $34 million to support final preparation activities prior to its 1989 launch. A $3 million increase is expected for the Ulysses project, a joint mission between NASA and the European Space Agency (ESA) to study the Sun. The Ulysses is scheduled for a 1990 launch.

The 1989 request for R&D activities for life sciences is $102 million, representing an increase of 48 percent, or $33 million. The life sciences program conducts research and development on space-related biological and medical sciences. A $24 million increase to $55 million is proposed for the life science flight experiment which will conduct the first dedicated life sciences mission, Spacelab Life Sciences-1, planned for launch in 1991. Research and analysis, expected to increase by $9 million, will continue research activities in five major areas: space medicine, space biology, controlled ecological life support systems, exobiology, and biospheric research.

Space and Terrestrial Applications

The 1989 R&D budget authority for space and terrestrial applications provides an increase of 2 percent, or $11 million, to $714 million. The space and terrestrial applications program consists of five disciplinary-oriented programs: environmental observations, solid earth observations, materials processing in space, information systems, and communications.

The environmental observations program, scheduled to increase by 17 percent, or $52 million, to $362 million in 1989, is an integral part of NASA's earth sciences and applications efforts to understand the earth as a planet, its dynamics, processes, habitability, and solar-terrestrial environment. R&D support for the Upper Atmosphere Research Satellite (UARS) is anticipated to grow by 16 percent to $102 million. The UARS, which is scheduled for a 1991 launch, will provide an orbital observatory capable of obtaining data not presently available about the earth's upper atmosphere. A 30-percent, or $22 million, increase to $96 million is proposed for the Ocean Topography Experiment (TOPEX), which is a collaborative effort with the French Space Agency (CNES) to be launched aboard the Ariane in 1991.

The 1989 request maintains 1988 R&D funding levels for the following programs: the upper atmosphere research and analysis program, which is concerned with verification of theoretical models of the phenomenon of ozone depletion; the Atmospheric dynamics and radiation program, which will continue its activities on the Global Backscatter Experiment (GLOBE), and the Laser Atmospheric Wind Sounder (LAWS) for use on the future earth Observing System (EOS); airborne science and applications; and oceanic processes research and analysis. An increase of $15 million is expected for payload and instrument development resulting from a reorganization of program elements and an increased emphasis on the Earth Observation System. The Scatterometer is scheduled for a $6 million decrease from 1988, which reflects the completion of some development aspects and continued support of others.

Elements of the missions operations and data analysis program and the instrument development programs, as well as the entire Tether Satellite payloads, space physics research and analysis, and global geospace science programs, have been transferred to the physics and astronomy program due to the recent reorganization (effective beginning 1988) of the Office of Space Science and Applications and the creation of the Space Physics Division.

Budget authority for research and development in the solid earth observations program is proposed to rise by 10 percent, or $8 million, to $81 million in 1989. This program is a central element of NASA's earth science and applications effort. It conducts investigations on the processes controlling the surfaces and the interior of the earth as well as the interactions among the solid earth and the atmosphere and the oceans. The

R&D budget authority for space and terrestrial applications
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$675	$703	$714
Environmental observations 1/	314	310	362
Upper Atmosphere Research Satellite mission (UARS)	112	88	102
Ocean Topography Experiment (TOPEX)	19	74	96
Upper atmosphere research & analysis	32	32	33
Atmospheric dynamics and radiation	31	31	32
Airborne science and applications	-	22	23
Oceanic processes research & analysis	18	20	21
Payload and instrument development	10	4	19
Mission operations and data analysis	33	15	18
Scatterometer (NSCAT)	32	22	16
Interdisciplinary research & analysis	1	1	1
Space physics research and analysis	21	*	*
Tethered satellite payloads	5	*	*
Solid earth observations	71	73	81
Geodynamics	31	32	33
Payload and instrument development	21	21	25
Research and analysis	19	21	23
Materials processing in space	47	62	72
Microgravity shuttle/space station payloads	33	49	59
Research and analysis	13	13	13
Information systems	21	21	22
Communications	102	94	16
Advanced communications research	13	14	10
Radio science and support studies	3	3	3
Communications data analysis	1	1	1
Search & rescue	1	1	1
Adv. comm. technology satellite (ACTS)	83	75	-
Research and program management	120	144	161

1/ As of 1988, program budgets reflect transfers resulting from the reorganization of the Office of Space Science and Applications.

* Transferred to Physics and Astronomy as a result of reorganization

SOURCE: National Science Foundation, SRS

geodynamics program, which develops instruments and techniques to measure the movement of the earth's crust, its rotational dynamics, global gravity, and magnetic fields, is proposed to increase by $11 million to $33 million in 1989. Payload and instrument development, with a proposed $4 million increase, will continue to develop Shuttle Imaging Radar technology for earth-viewing remote sensing. Research and analysis is expected to increase $2 million to $23 million in 1989.

R&D programs within the materials processing in space program, which is directed toward the understanding of the fundamental nature of matter through the unique microgravity environment attained in space flight, are scheduled to increase by $10 million, to $72 million in 1989. This growth is attributable to the additional R&D funds proposed for the microgravity Shuttle/Space Station payloads program, which supports development of microgravity experiments for future Shuttle and Space Station payloads. The proposed budget authority for the research and analysis program is expected to remain at the 1988 level. The research and analysis program conducts ground-based research in areas such as metals and alloys, electronic materials, glass and ceramics, biotechnology, combustion, fluid dynamics and transport phenomena.

The information systems program is expected to receive $22 million in R&D support in 1989, $1 million over the 1988 level. The information systems program will continue its emphasis on science information systems in support of the space science and applications programs.

In 1989, R&D funding for the communications program is $16 million compared to $94 million in 1988. This decrease of $83 million is a result of the scheduled elimination of the Advanced Communications Technology Satellite (ACTS), in accordance with Administration's position that it is more appropriately and effectively undertaken by the private sector. Other communications programs are proposed to remain at about 1988 levels.

Space Research and Technology

In 1989, R&D budget authority for space research and technology is $531 million, representing a 58-percent, or $196 million, increase over 1988. The additional funds will support a significant expansion in the space research and technology program, enabling a greater emphasis to be placed on focused technology (the Civil Space Technology Initiative and Pathfinder) and the university space research programs. Furthermore, a shift of emphasis is proposed in the research and technology base from near-term projects to exploration of emerging areas with long-range benefits.

R&D funding for the Civil Space Technology Initiative (CSTI), is scheduled to rise 38 percent over 1988 to $153 million in 1989. Established in 1988, the CSTI program is a mission-oriented program directed at refocusing and augmenting key technologies to enhance our capabilities for operations to, from, and in earth orbit.

The 1989 request includes significant increases over the 1988 level for two of the CSTI programs. The CSTI propulsion program is proposed to receive $46 million, twice the 1988 level, to support the design and development of advanced propulsion systems for future low-cost reusable earth-to-orbit (ETO) vehicles. The CSTI vehicle program anticipates a 90-percent increase to $27 million which will support vehicle design and environmental technologies applicable to the development of the aeroassist orbital transfer vehicle as part of the aeroassist flight experiment. Other CSTI programs such as automation and robotics, large structures and control, information technology and high capacity power, will increase slightly or remain at 1988 levels.

The research and technology base program, with a proposed increase in budget authority of $27 million to $131 million in 1989, provides resources for innovative and fundamental research for future civilian space missions. R&D activities within this program are directed toward elevating fundamental technological advances and concepts to the demonstration level.

The propulsion technology program, with a $7 million increase to $19 million, focuses on key lifetime performance issues associated with space propulsion systems. The proposed R&D budget authority is $17 million for the materials and structures program to continue development of materials used in space, and design of structures used for lightweight vehicles. The university space research program is expected to grow four-fold over 1988 to $16 million to augment the university space research program, which includes research centers and university research and curriculum programs. Other programs within the research and technology base are expected to remain about at the 1988 levels.

R&D budget authority for the space research and technology program
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$306	$335	$531
Civil space technology initiative	-	111	153
Propulsion	-	23	46
Vehicle	-	14	27
Automation and robotics	-	24	25
Large structures and control	-	21	25
Information technology	-	16	17
High-capacity power	-	12	14
Research and technology base	126	104	131
Propulsion	18	13	19
Space flight	19	21	18
Materials and structures	20	15	17
University space research	-	4	16
Space energy conversion	20	12	14
Aerothermodynamics	11	10	11
Space data and communications	13	8	9
Information sciences	8	7	9
Systems analysis	6	5	7
Controls and guidance	7	5	7
Human factors	2	4	5
Pathfinder program	-	-	98
Operations technology	-	-	40
Exploration technology	-	-	17
Mission studies	-	-	15
Transfer vehicle technology	-	-	14
Humans-in-space technology	-	-	13
Systems technology programs	72	*	*
Research and program management	108	120	148

*Funds transferred to CSTI in 1988

SOURCE: National Science Foundation, SRS

The 1989 budget proposes a total of $98 million for a new program, Project Pathfinder. This effort will support R&D activities in a wide range of technological areas including automated rendezvous and docking, orbital transfer propulsion, optical communications, and closed-loop life support systems. These technologies are considered key to achieving the national long-range goal of expanding human presence beyond the earth's orbit into the Solar system. The exploration program will be concerned with gaining scientific knowledge and technical understanding at mission sites on the Moon and Mars. The space operations element will address critical technologies for in-situ materials processing, fabrication, assembly, and repair of systems in earth, lunar, or Martian orbits and surfaces. The human-in-space program is concerned with improving astronaut productivity and health. The transfer vehicle element supports transportation to and from geostationary earth orbit, the Moon, Mars, and other planets.

GENERAL SCIENCE

In 1989, general science R&D budget authority is proposed at $2.5 billion--an increase of 18 percent, or $383 million, over 1988. The National Science Foundation (NSF) and the Department of Energy support the research activities within this function. The programs that are classified as general science are viewed as contributing to the Nation's broad science and engineering research base and complementing the basic research undertaken in support of the various agency missions. Approximately 95 percent of the R&D budget for general science will support basic research in 1989.

R&D funding in 1989 for the general science function provides for increased levels of support for the following major research activities:

- An increase of $304 million, or 20 percent, to $1.8 billion for the National Science Foundation. This increase includes $150 million in 1989 for the initiation of the Science and Technology Research Centers program.
  - An increase of $28 million, or 6 percent, in mathematical and physical sciences programs to $476 million.
  - An increase of $28 million, or 10 percent, in geosciences programs to $317 million.
  - An increase of almost $24 million, or 14 percent, in engineering programs to $195 million.
  - An increase of $23 million, or 9 percent, in biological, behavioral, and social sciences programs to $289 million.
  - An increase of $21 million, or 20 percent, in computer and information science and engineering programs to $127 million.
  - An increase of $11 million, or 10 percent, in U.S. Antarctic research to $124 million.
- An increase of approximately $80 million, or 13 percent, over 1988 to a total of $707 million for the general science programs within the Department of Energy. This level of funding includes increased support for research related to the Superconducting Super Collider.

R&D budget authority for general science
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$2,042	$2,150	$2,533
National Science Foundation	1,471	1,523	1,827
Mathematical and physical sciences	440	448	476
Geosciences	284	289	317
Biological, behavioral, and social sciences	259	266	289
Engineering	163	172	195
Science and Technology Centers	-	-	150
Computer information science and engineering	100	106	127
U.S. Antarctic program	103	113	124
Scientific, technological, and international affairs	40	40	47
Science and engineering education	11	14	16
Special foreign currency	1	-	-
Program development and management	70	76	86
Department of Energy	571	627	707
Basic Research User Facilities	335	375	441
General Science and Research	236	253	266

SOURCE: National Science Foundation, SRS

National Science Foundation

In 1989, nearly three-quarters of general science support, $1.8 billion, is provided by the National Science Foundation. This represents an increase of almost $304 million, or 20 percent, over 1988. Funding for basic research accounts for approximately 94 percent of the NSF research budget and is scheduled to increase $290 million, or 20 percent, to $1.7 billion. NSF programs will continue to emphasize strengthening disciplinary research programs; developing human resources and broadening participation in science and engineering research by underrepresented groups and institutions; and enhancing research support in the Antarctic.

The 1989 request also includes funding--$150 million--for the establishment of the Science and Technology Centers. These new science and technology centers will expand upon the research center concept initiated in 1985 with the establishment of the Engineering Research Centers program. The $150 million proposed for 1989 would provide funding for about 12-15 centers for periods up to five years.

Mathematical and physical sciences

Research in mathematical and physical sciences (MPS) is expected to increase $28 million, or 6 percent, to $476 million in 1989. MPS accounts for 26 percent of NSF research funding. The MPS disciplines--materials research, physics, chemistry, astronomy, and mathematics--provide the knowledge base upon which future technological developments are founded. MPS supports both individual and group research, with emphasis on academic research. Cross-disciplinary efforts within MPS receiving increased funding include cosmology, and materials chemistry and processing.

Materials research is scheduled to increase $8 million, or 7 percent, providing for additional support for the Materials Research Groups program, and materials chemistry and processing initiatives. Fundamental research in superconductivity will also receive increased funding.

The physics program, with a proposed increase of $8 million, or 7 percent, will emphasize intermediate energy nuclear physics and nuclear physics. Elementary particle physics, the largest activity within the physics program, is the only subdiscipline scheduled for a reduction in 1989.

Chemistry research is expected to increase $5 million, or 5 percent. The 1989 request provides for growth in the Materials Chemistry and the Chemistry of Life Processes initiatives. In addition, the Postdoctoral Fellowships in Chemistry program is scheduled to receive increased support in 1989.

The astronomical sciences program, supporting research at universities and the three national astronomy centers, is scheduled to increase $3 million, or 5 percent, in 1989. The 1989 request provides for research on cosmology and the structure of the universe, as well as support for the Very Large Baseline Array (VLBA) and for the solar oscillations experiment. The National Optical Astronomy Observatories, providing large optical and infrared telescopes and related instruments, support advanced research in extragalactic, galactic, stellar, and planetary astronomy. The National Radio Astronomy Observatory supports research in radio astronomy. The National Astronomy and Ionosphere Center supports basic research in radio astronomy, radar astronomy and the atmospheric sciences.

Research funding for the mathematical sciences is expected to increase $4 million, or 7 percent, over 1988. Emphasis continues to be placed on providing additional support to graduate students and postdoctorates in mathematics, as well as encouraging closer interaction between the mathematical sciences and other areas of science and engineering. Computational mathematics is scheduled to receive the largest increase within the mathematical sciences.

R&D budget authority for mathematical
and physical sciences
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$440	$448	$476
Materials research	109	111	119
Physics	105	106	113
Chemistry	94	94	99
Astronomical sciences	73	74	77
Mathematical sciences	60	64	68

SOURCE: National Science Foundation, SRS

Geosciences

Research funding in the geosciences reflects a proposed increase of $28 million, or 10 percent, to $317 million in 1989. Geosciences research accounts for nearly 13 percent of the NSF research budget. The geosciences--ocean, atmospheric and earth sciences, and arctic research--provide for multidisciplinary research on the earth as a complete system. The Global Geosciences initiative continues to be the primary focus of geosciences research. The initiative supports research activities in the following areas: Global Tropospheric Chemistry (GTC); Tropical Ocean and Global Atmosphere (TOGA); the World Ocean Circulation Experiment (WOCE); Global Ocean Flux Studies (GOFS); Ridge Crest Processes (RCP); solid earth studies; Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR); global ecosystems dynamics; and global changes in earth history.

The ocean sciences program is scheduled to increase $11 million, or 8 percent, in 1989. The proposed increases in research support will continue to focus on global change through interdisciplinary ocean studies which form the major components of the Global Geosciences initiative, and on biotechnology-related research. Research activities seek to increase the understanding of factors controlling the physical, chemical, geological, and biological processes in the ocean and at its boundaries. The ocean drilling program's research activities attempt to further the knowledge of the composition, history and processes affecting the sea floor.

The atmospheric sciences research budget is expected to increase $6 million, or 7 percent, over 1988. The atmospheric sciences program supports research on both the upper and lower atmosphere. Activities related to the Global Geosciences initiative, such as the TOGA, CEDAR and GTC programs, will receive increased support in 1989. Research support for mesoscale meteorology, which focuses on severe weather phenomena, will also receive increased funding. The planned phase-out of the Global Atmospheric Research program, funded through atmospheric sciences project support, will be complete in 1989. Funding for the National Center for Atmospheric Research (NCAR), the major research center in atmospheric sciences, supports the Global Geosciences initiative through the GTC and TOGA programs.

Research support for the earth sciences in 1989 reflects a proposed increase of $8 million, or 16 percent, over the 1988 level. Approximately one-half, or $4 million, of this proposed increase will support the Continental Lithosphere program. The Continental Lithosphere program's objective is to gain a greater understanding of the composition and origin of the continents and the forces that govern their change. The Global Seismic Network and Global Positioning System (satellite applications) continue to receive emphasis. The 1989 request provides for continued support of the Global Geosciences initiative through increased funding for earth sciences research using data from global seismic networks and geodetic instrumentation, and expanded studies of the geological record to further the understanding of changes in the global environment. Research emphasis will be placed on the physics and chemistry of geological materials and the study of earthquakes.

The arctic research program is scheduled for an increase of nearly $3 million, or 30 percent, in 1989. Arctic research activities encompass all aspects of the Arctic environment, including the ocean floor, the ice cover and space, where solar radiation interacts with the earth's atmosphere; as well as the arctic land mass and its plants and wildlife. The Arctic research program's goal is not only to increase the knowledge of the Arctic itself, but to use this knowledge in areas related to the global environment. The 1989 request provides funding for the new Arctic Systems Science (ARCSS) program that will focus on environmental change in the Arctic. Funding will also provide for the initiation of the Greenland ice-coring project planned for 1989.

R&D budget authority for geosciences
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$284	$289	$317
Ocean sciences	134	135	147
Ocean sciences research support	67	67	73
Oceanographic centers and facilities	37	37	41
Ocean drilling program	30	31	32
Atmospheric sciences	92	94	100
Atmospheric sciences project support	48	49	53
National Center for Atmospheric Research	40	41	43
Upper atmospheric facilities	4	4	4
Earth sciences	50	51	59
Arctic research	8	8	11

SOURCE: National Science Foundation, SRS

Biological, behavioral, and social sciences

The 1989 request of $289 million for biological, behavioral, and social sciences (BBS) research represents an increase of $23 million, or 9 percent, over 1988. BBS research funding accounts for 11 percent of the NSF research budget in 1989.

Biotechnology research continues to receive increased support, with emphasis on basic research in genetic and molecular structure. Research efforts in biological communications, a multidisciplinary field focused on how signals are received and processed within and between organisms, will be expanded in 1989. Research on global ecosystems dynamics, specifically as it relates to land-sea interactions, will continue to be emphasized. The first phase of computer networking of Long-Term Ecological Research (LTER) sites will also be initiated.

Biotic systems and resources activities are expected to increase $6 million, or 11 percent, in 1989. Research in this area focuses on understanding the interrelationships of organisms as they exist in nature. The ecosystems studies program is scheduled to receive the largest increase--$5 million or 25 percent--in 1989. This proposed growth provides increased support for research aimed at advancing biotechnology in areas such as survival, persistence and spread of microbial species in the natural setting, using molecular genetic techniques; and genetic differences among populations of microbes, plants and animals. The 1989 request also includes funding for expanding ecosystem research activities on the inshore marine environment and increasing the number of long-term ecological research sites as part of the Global Geosciences initiative.

Cellular biosciences research is expected to increase $3 million, or 6 percent, in 1989. This program emphasizes experimental research to examine how life processes are initiated, regulated and integrated from the level of genes to cells, organs and the entire organism. The increase in 1989 will support research in multidisciplinary fields and in areas directed toward furthering the development of biotechnology. Since competitive research in these areas requires the use of immunological and molecular genetics techniques that include new methods for gene transfer as well as image enhancement, computer simulation and other advanced physical and electronic approaches, the average award size will be increased to accommodate these needs.

Molecular biosciences research support is proposed to increase $4 million, or 8 percent, in 1989. Emphasis within the molecular biosciences is on research leading to advances in plant molecular biology and in biotechnology, and on all aspects of research in genetic biology. In addition, interdisciplinary research efforts involving the physical and chemical sciences will be expanded. Special focus is on fundamental research in genetics and macromolecular structures.

The behavioral and neural sciences are scheduled to receive an increase $3 million, or 6 percent, with priority given to research on the biological basis of behavior to augment the major initiative begun in 1988 on the neurobiology of learning and memory. The focus in anthropology will continue to be on improving ethnographic research methods and cross-cultural studies.

The instrumentation and resources program, established in 1988 to coordinate support for infrastructure and research resources, is expected to increase $4 million, or 13 percent, in 1989. Increased funding will support genetic strain and stock centers; development of second generation data banks on macromolecules; and instrumentation needs in the ecological sciences, and behavioral and neural sciences. The 1989 request also provides for ongoing research activities, including collaborative efforts in the development of techniques and instrumentation for automated sequencing of DNA, and for the microchemical analyses of proteins, nucleic acids and carbohydrates, as well as continued support for the Plant Science Centers.

Research funding for the social and economic sciences is expected to grow $2 million, or 8 percent, in 1989. This program supports disciplinary and interdisciplinary research on human social behavior and social organizations and systems. Emphasis will be placed on a new research initiative on organizational effectiveness.

R&D budget authority for biological, behavioral,
and social sciences
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$259	$266	$289
Biotic systems and resources	58	59	65
Cellular biosciences	54	54	58
Molecular biosciences	44	45	48
Behavioral and neural sciences	43	44	47
Instrumentation and resources	29	34	38
Social and economic sciences	31	30	33

SOURCE: National Science Foundation, SRS

Engineering

Engineering research is scheduled to increase $24 million, or 14 percent, to $195 million in 1989. Engineering research accounts for 8 percent of the NSF research budget in 1989. This proposed increase allows for growth in high priority areas, especially those relating to superconductivity, as well as for expansion of the Engineering Research Centers program. Areas receiving high priority in 1989 include: an initiative to strengthen U.S. manufacturing capabilities; research in emerging technologies, such as biotechnology, lightwave technology, bioengineering and neuroengineering; and the establishment of an Ocean Engineering Systems program.

The cross-disciplinary research program will receive the largest increase--$7 million, or 20 percent--within the engineering research total. This increase is largely the result of the continued expansion of the Engineering Research Centers (ERC) program established in 1985. These centers focus on research on major technological advances by working with industry to define long-term goals and then selecting research projects relevant to these goals. ERC funding in 1989 is $40 million, and provides for a minimum of two new centers, bringing the total to 18 centers. Areas of focus at the centers include manufacturing and design; optoelectronics, microelectronics and telecommunications; biotechnology and bioengineering; and resource recovery and utilization. The Industry/University Cooperative Research Centers (IUCRC) program will receive a slight increase over 1988. These university-based centers focus on fundamental research in areas defined by the supporting firms.

Chemical, biochemical, and thermal engineering research will receive a $3 million, or 10 percent, increase in research support in 1989. This program seeks to strengthen the engineering knowledge base used for the further development of new processes, techniques, and materials essential to the production of chemicals, manufactured components, finished products, and energy resources. Priority will be given to research on microscale chemical processing, and to augmenting undergraduate research programs.

Mechanics, structures and materials engineering funding is expected to increase $3 million, or 12 percent. This program supports fundamental research on the behavior, response, and failure of materials, structures, machines, and their components. The largest increases are proposed for solid and geomechanics, and materials engineering and processing.

The critical engineering systems program is scheduled to increase $3 million, or 13 percent, over 1988. A major focus within critical engineering systems is research on earthquake hazard mitigation, receiving $16 million. The 1989 request also provides for initiation of the new Ocean Engineering Systems program.

Electrical, communications and systems engineering, which will increase $2 million, or 8 percent, supports research on the analysis, design, and fabrication of devices and systems involving electrical and electronic technologies. The largest increase is proposed in the instrumentation, sensing and measuring program, and allows for a new thrust in small electromechanical and electronic devices.

Emerging engineering technologies research is proposed to receive a $3 million, or 17 percent, increase in 1989. This program supports biotechnology, bioengineering and research to aid the handicapped, computational engineering, lightwave technology, and neuroengineering. In 1989, the Emerging Technology Initiation program will be established, focusing on two emerging technologies each year.

Design, manufacturing, and computer-integrated engineering support is expected to increase $2 million, or 15 percent, over 1988. This program supports research aimed at the long-term goal of integrating design and manufacturing in order to increase the productivity and competitiveness of U.S. manufacturing industries. The 1989 request provides support for the manufacturing initiative to explore new concepts, introduce new technologies, and address issues involved in manufacturing systems.

R&D budget authority for engineering
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$163	$172	$195
Cross-disciplinary research	32	36	43
Chemical, biochemical, and thermal engineering	28	29	32
Mechanics, structures, and materials engineering	25	26	29
Critical engineering systems	25	25	28
Electrical, communications, and systems engineering	23	23	25
Emerging engineering technologies	16	17	19
Design, manufacturing, and computer-integrated engineering	14	15	18

SOURCE: National Science Foundation, SRS

Computer and information science and engineering

Computer and information science and engineering (CISE) research funding is scheduled to receive a proposed increase of $21 million, or 20 percent, to $127 million in 1989. CISE research accounts for 5 percent of the NSF research budget. The major focus of CISE, which was created in 1986 by integrating relevant subactivities from within NSF, is to improve the fundamental understanding of computing and information processing, and to enhance the training of scientists and engineers who will use and further that understanding. Parallel processing research, especially the software requirements of new parallel computer architectures, will receive increased emphasis, along with new methods of information retrieval and integration, improved techniques for Very Large Scale Integration (VLSI) design and testing, and expanded educational activities in microelectronics system design.

Advanced scientific computing research will receive a proposed increase of $7 million, or 27 percent, over 1988. In addition to providing funding for the five national supercomputer centers, this program supports the development of innovative software, numerical methods and graphical techniques to meet the needs of the scientific and engineering communities. The utilization and understanding of parallel processing, through access to new experimental systems and developing new algorithms, will continue to be emphasized. Efforts to standardize scientific supercomputer software will be expanded.

Computer and computational research is scheduled to increase $2 million, or nearly 12 percent, in 1989. Parallel computation is the primary focus of research supported by this program, and the 1989 request provides funding for expanded research activities on the utilization of parallel computing systems focused on computation and software. The recent introduction of massively parallel computer architectures has intensified the need for new software approaches, algorithms, languages and systems to make these machines effective. Support for fundamental research on the nature of parallel computing in such areas as computational complexity, algorithm design and analysis, performance analysis, programming language semantics, and compilers is emphasized.

Information, robotic and intelligent systems research is expected to increase $2 million, or 12 percent, in 1989. Research within this program focuses primarily on how to provide the best computational structures and physical devices to facilitate the use of the various information forms, such as language, speech, images, signals or sensory data, text, numbers and signals. Continued emphasis is placed on knowledge and database systems research, and robotics and machine intelligence research activities.

The networking and communications research and infrastructure program is scheduled to increase $6 million, or 53 percent, over 1988, primarily due to enhanced support for NSFNET. NSFNET is a network of computer networks, or "internet", developed to provide access to the NSF Supercomputer Centers and link researchers to unique resources, such as radiotelescope arrays and biotechnology databases. The networking and communications research and infrastructure program supports research on communications theory and network design. In this dynamic field of technology, areas of research include fiber optics, modeling methods, and VLSI.

Funding for cross-disciplinary activities will increase approximately $1 million, or 3 percent, over 1988. The 1989 request allows for a slight increase in instrumentation support for the design and use of parallel computing systems. This new research program, created from two program elements within computing and computational research, supports research in all CISE disciplines and provides funding for the development and evaluation of experimental research activities.

Microelectronics information processing systems research funding will increase $3 million, or 21 percent, in 1989. This program supports research related to the design, fabrication and testing of microelectronic integrated information processing systems. The largest increases are proposed for the experimental systems and systems prototyping programs, and are aimed at increasing university participation in these areas.

R&D budget authority for computer and information science and engineering
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$100	$106	$127
Advanced scientific computing	26	27	34
Computer and computational research	19	20	22
Information, robotics and intelligent systems	17	18	20
Networking and communications research and infrastructure	10	12	18
Cross-disciplinary activities	16	17	18
Microelectronics information processing systems	12	13	16

SOURCE: National Science Foundation, SRS

U.S. Antarctic Program

Research funding for the U.S. Antarctic Program is proposed at $124 million in 1989, reflecting an increase of $11 million, or 10 percent, over 1988. The U.S. Antarctic Program, accounting for 5 percent of the NSF's research funding, supports studies on the physical environment of Antarctica and seeks to integrate that knowledge into a global context.

Studies focus on the solid earth, the surrounding ice and oceans, the atmosphere, and the terrestrial and marine biota. Research efforts concerning the seasonal ozone depletions in the stratosphere over the Antarctic continent and its biological effects continue to receive emphasis. Since most of the world's ice is in Antarctica, the ice sheet provides valuable data on climatic and atmospheric conditions over the past 200,000 years. Ongoing research efforts include glacier dynamics and geological studies.

The operations support program is scheduled to grow $7 million, or 8 percent. This growth in funding provides for the lease of a ship with icebreaking capabilities, as well as the operation of other research ships and the direct support of R&D efforts. Research funding (excluding construction) within the major construction and procurement appropriation is expected to increase nearly $3 million, or 18 percent, in 1989. The U.S. Antarctic research program is expected to increase $2 million, or 15 percent, over 1988.

R&D budget authority for U.S. Antarctic program
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$103	$113	$124
Operations support program	77	85	92
Major construction and procurement	13	14	16
U.S. Antarctic research program	13	14	16

SOURCE: National Science Foundation, SRS

Scientific, technological, and international affairs

Research activities within scientific, technological and international affairs (STIA) are proposed at $47 million in 1989, reflecting an increase of $6 million, or 16 percent, over 1988. STIA supports and coordinates research programs that cut across all the scientific and engineering disciplines within the National Science Foundation and links researchers in various sectors.

Industrial science and technological innovation is scheduled to increase $2 million, or 10 percent, in 1989. This increase is dedicated entirely to the Small Business Innovation Research (SBIR) program. Research initiation and improvement research funding is expected to increase $4 million, or 33 percent, over 1988. This proposed level of funding provides for increases in the Minority Research Centers of Excellence program, as well as for the initiation of the Research Careers for Minority Scholars program. International cooperative scientific activities are expected to increase $1 million, or 8 percent, in 1989. This proposed growth will provide support for increased activities by U.S. researchers in Japan and for new initiatives with Pacific Rim Nations. Funding for research activities within science resources studies and policy research and analysis will remain relatively stable.

R&D budget authority for scientific, technological, and international affairs
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$40	$40	$47
Industrial science and technological innovation	17	17	19
Research initiation and improvement	11	11	15
International cooperative scientific activities	11	11	12
Science resources studies	1	1	1
Policy research and analysis	1	1	1

SOURCE: National Science Foundation, SRS

Department of Energy

In 1989, funding for the Department of Energy's general science programs is proposed at $707 million, which represents an increase of almost $80 million, or 13 percent, over 1988. This proposed level of funding provides basic research support for the newly established Basic Research User Facilities (BRUF) program and the General Science and Research activity. The 1989 request includes increased support for research programs related to the Superconducting Super Collider (SSC). The DOE general science programs support basic research in areas that are expected to have long-term impacts on energy development and utilization.

Basic Research User Facilities

Beginning with the 1989 budget, funding for basic science research activities that are conducted at major DOE user facilities are funded through the Basic Research User Facilities appropriation. In 1989, BRUF funding of general science programs is estimated at $441 million. This represents an increase of $66 million, or 18 percent, over the 1988 level of $375 million. The proposed growth provides for increased R&D efforts related to superconducting magnets and other technical components required for the Superconducting Super Collider accelerator facility and increased utilization of all major on-line high energy and nuclear physics accelerators. The three general science BRUF programs--high energy physics, nuclear physics and the Superconducting Super Collider--account for over 60 percent of the Department of Energy's general science R&D funding in 1989.

In 1989, funding for high energy physics BRUF is proposed at $302 million. This is $25 million, or 9 percent, higher than the 1988 level. Experimental research in high energy physics usually requires the use of large particle accelerators, colliding beam devices, and large particle detectors. This program supports research at DOE's three high energy physics accelerator centers--Brookhaven National Laboratory, Fermilab and the Stanford Linear Accelerator Center (SLAC). The proposed Superconducting Super Collider will complement these existing centers. The 1989 request provides for long-range accelerator and detector R&D studies to develop new and advanced concepts and technologies for accelerator improvements and for future accelerators with greater research capabilities.

Fermilab is scheduled to operate the Tevatron collider and fixed target programs to be shared equally among colliding beam and fixed target experiments, with emphasis given to research activities focused on improving Tevatron operation with 1 TeV beam energies. Research efforts at SLAC will continue to focus on increased luminosity and performance of the collider. Emphasis at Brookhaven will be on research efforts in support of the Alternating Gradient Synchrotron (AGS) booster project.

Nuclear physics BRUF research funding is scheduled to increase $2 million, or 3 percent, to $75 million in 1989. Nuclear physics BRUF research focuses on medium energy nuclear physics and heavy ion nuclear physics. This program utilizes the following facilities: the Los Alamos Meson Physics Facility (LAMPF) at Los Alamos, the Bevalac at Lawrence Berkeley Laboratory, and the Tandem/AGS at Brookhaven National Laboratory. Efforts continue on research activities related to the construction of the Continuous Electron Beam Accelerator Facility (CEBAF) at Newport News, Virginia begun in 1987.

R&D funding for the Superconducting Super Collider BRUF program is expected to more than double between 1988 and 1989--increasing $39 million to $64 million in 1989. This increase will allow for finalization of the design of the superconducting dipole magnets and other related systems that will enable the detector development program to proceed. A major new thrust in this research will be the initiation of fabrication of pre-production full-scale superconducting magnets. Research activities on SSC technical systems will also proceed at an increased level of effort.

R&D budget authority for DOE general science
basic research user facilities (BRUF)
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$335	$375	$441
High energy physics	243	277	302
Facility operations	204	233	257
High energy technology	39	43	45
Nuclear physics	72	73	75
Medium energy nuclear physics	48	49	50
Heavy ion nuclear physics	24	24	25
Superconducting Super Collider	20	25	64

SOURCE: National Science Foundation, SRS

General Science and Research

The General Science and Research program, consisting of two major activities--high energy physics and nuclear physics--is expected to increase $13 million, or 5 percent, in 1989 to $266 million. This program accounts for almost 40 percent of DOE's general science funding.

Funding for the high energy physics program, the largest activity within General Science and Research with $145 million, is expected to increase $8 million, or 6 percent, in 1989. This program supports basic research directed at understanding the nature of matter and energy at the most fundamental level, and the basic forces which govern all processes in nature.

High priority is given to research programs utilizing the Tevatron proton-antiproton colliding beam capability at Fermilab and the Stanford Linear Collider (SLC) electron-positron collider, as well as the Tevatron fixed target program. Continued emphasis is placed on research utilizing the Alternating Gradient Synchrotron at Brookhaven focusing on rare kaon decay and neutrino experiments, and the upgraded Positron-Electron Project (PEP) electron-positron collider with the improved Time Projection Chamber detector. The 1989 request also provides funds for continued support to university-based research groups.

The physics research program, increasing $7 million to $124 million in 1989, provides support for research groups at universities and laboratories conducting experimental and theoretical research in high energy physics. The high energy technology program is primarily carried out in DOE laboratories and supports nearer-term R&D activities related to existing detector facilities. The University Program will receive an additional $5 million, the largest increase within the physics research program, for a total of nearly $80 million in 1989.

Funding for high energy technology research is expected to increase $1 million to $21 million in 1989. This program provides the technological base for maintaining and improving the scientific effectiveness, reliability, and efficiency of existing detector facilities, and for extending the capabilities of detectors and data analysis capabilities through new concepts and technologies.

Nuclear physics funding is expected to increase $5 million, or 4 percent, to $118 million in 1989. This program supports basic research to better understand the properties, structures, and interactions of atomic nuclei and nuclear matter. Current efforts include research focused on relativistic heavy ion collisions to create a quark-gluon, which simulates a stage of evolution of the universe that disappeared ten millionths of a second after the big bang start of the universe. The nuclear physics program also provides funding for research and development in support of next-generation accelerators.

The heavy ion nuclear physics program supports research using accelerators located at three large universities and four national laboratories. Research activities focused on support for the proposed Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory will receive increased emphasis. Heavy ion nuclear physics research funding is scheduled to receive an additional $2 million for a total of $43 million in 1989.

The medium energy nuclear physics program provides for increased research support in electromagnetic physics, as well as accelerator research at the Continuous Electron Beam Accelerator Facility. Medium energy nuclear physics research funding is expected to increase $2 million to $38 million in 1989. Research efforts within the low energy nuclear physics program and the nuclear theory program will remain at 1988 levels.

R&D budget authority for DOE general science
and research program
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$236	$253	$266
High energy physics	130	137	145
Physics research	109	117	124
High energy technology	21	20	21
Nuclear physics	103	113	118
Heavy ion nuclear physics	36	41	43
Medium energy nuclear physics	33	36	38
Low energy nuclear physics	24	26	26
Nuclear theory	10	11	11
Program direction	3	3	3

SOURCE: National Science Foundation, SRS

ENERGY

Total R&D budget authority for energy programs in 1989 is $2.5 billion, which is 16 percent, or $345 million, more than the $2.1 billion requested in 1988. Energy R&D activities in 1989 primarily emphasize long-term, high risk efforts which support a mix of technologies aimed at expanding domestic energy supplies, achieving greater efficiency in energy use, supporting nuclear regulation by providing technical bases for regulatory action to ensure public health and safety, and developing information to guide the development and use of energy resources in an environmentally acceptable manner.

Three agencies provide support for R&D efforts in energy: the Department of Energy, the Nuclear Regulatory Commission (NRC), and the Environmental Protection Agency (EPA).

The overall increase in 1989 R&D funding for energy can be primarily attributed to the following changes in programs:

- A proposal to more than double the 1988 R&D funding level for the fossil energy program to $698 million in 1989.
- An increase of 15 percent, or $31 million, in biological and environmental research to $237 million.
- An increase of 23 percent, or $26 million, in the R&D programs of the Nuclear Regulatory Commission to $137 million.
- An increase of 6 percent, or $19 million, in magnetic fusion to $317 million.
- An increase of 3 percent, or $14 million, in supporting research and technical analysis to $455 million.
- An increase of 14 percent, or $10 million, in uranium enrichment to $84 million.

Although overall R&D support for energy-related programs is increasing, the following energy R&D activities are scheduled to decrease:

- A decrease of 42 percent, or $58 million, in energy conservation to $79 million.
- A decrease of 21 percent, or $31 million, in solar and other renewable energy to $115 million.
- A decrease of 10 percent, or $31 million, in nuclear fission to $293 million.

R&D budget authority for energy
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$2,053	$2,126	$2,471
Department of Energy	1,868	1,959	2,279
Fossil energy	291	332	698
Supporting research and technical analysis	388	441	455
Magnetic fusion	315	298	317
Nuclear fission	310	324	293
Biological and environmental research	177	205	237
Solar and other renewable energy	170	146	115
Uranium enrichment	72	74	84
Energy conservation	145	137	79
Nuclear Regulatory Commission	122	112	137
Environmental Protection Agency	63	56	55

SOURCE: National Science Foundation, SRS

Fossil energy

The 1989 R&D budget authority request of $698 million for fossil energy is more than twice the $332 million requested in 1988. The fossil energy program focuses on establishing an adequate scientific and engineering knowledge base to assist private sector efforts in developing and applying new technologies for the recovery and production of fossil and synthetic fuels.

The clean coal technology program was recently created to conduct cost-shared operations of technology projects demonstrating the future commercial applications of these technologies. R&D funding for this program in 1989 is expected to increase $480 million to $511 million. The 1989 budget level includes advanced appropriations to provide full funding for the government's share of a five-year program. This program has emerged as a major fossil energy initiative with funds directed toward the support of nine technology demonstration projects on retrofitting, repowering, and modernizing existing coal burning facilities. These demonstration projects are in accordance with the recommendations made in the U.S./Canadian report on acid rain.

Coal funding is expected to decrease 51 percent, or $106 million, to $101 million in 1989. Decreases are proposed for all subprograms, except for the magnetohydrodynamics program which is scheduled for termination in 1989. Despite the proposed reductions, the coal program will continue to conduct generic crosscutting research with a major thrust in acid rain-related technologies.

The petroleum R&D program in 1989 is proposed at $20 million, a 31-percent reduction from the 1988 level. Two of the three petroleum programs are scheduled for decreases, with the oil shale program receiving the largest decrease--89 percent or $8 million. Funding for the enhanced oil recovery program is scheduled for a 3-percent increase. The petroleum program supports research which could lead to improved technologies for the exploration, development and production of petroleum resources. Funding in 1989 includes an emphasis on enhanced recovery of light and heavy oils and on geoscience research designed to increase understanding of reservoir characteristics and recovery processes.

Cooperative R&D venture pool funding is scheduled for 1989 at a level of $10 million. These funds are proposed to be used for the initiation of a multi-year two-phase program for cooperative ventures in fossil energy technologies to ease the level of future oil imports, to increase the domestic resource base for moderately-priced liquid and gaseous fuels, and to increase the contribution of coal in applications currently dominated by gas and oil.

R&D budget authority for unconventional gas recovery is expected to decrease 84 percent, or $9 million, to $2 million in 1989. The goal of this program is to assist the private sector in developing cost-effective diagnostic and extraction technologies for unconventional gas resources. The 1989 budget request proposes a decrease in all gas R&D programs with the largest decrease in the Western tight gas sands experiments.

R&D budget authority for fossil energy
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$291	$332	$698
Clean coal technology	-	32	511
Coal	199	207	100
Coal technology and coal preparation	38	40	31
Advanced research and technology	26	23	21
Combustion systems	18	23	17
Coal liquefication	24	25	10
Heat engines and heat recovery	12	16	9
Fuel cells	29	31	6
Surface coal gasification	24	15	5
Underground coal gasification	2	3	(a)
Magnetohydrodynamics	26	32	-
Petroleum	26	29	20
Enhanced oil recovery	11	17	17
Advanced process technology	4	3	2
Oil shale	11	10	1
Cooperative R&D venture pool	-	-	10
Unconventional gas recovery	8	11	2
Program direction and management support	58	54	55

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Supporting research and technical analysis

In 1989, an increase of 3 percent, or $14 million, to $455 million is scheduled for supporting research and technical analysis. These programs focus on: areas of fundamental science that have the greatest potential impact on energy production; the assessment of energy-related technologies that have potentially high payoffs in the future; and the training of professionals in energy-related activities. The principal program is basic energy sciences which accounts for 95 percent of funding in supporting research and technical analysis.

The basic energy sciences program shows an increase of 4 percent, or $16 million, to $431 million in 1989. This program is responsible for generic longer-term energy-related research in support of both nuclear and non-nuclear energy technologies. This program supports research which provides the foundation for new technologies and improvements to existing technologies crucial to achieving the goals contained in the National Energy Plan. The majority of funding supports research in traditional scientific disciplines.

All of the research activities within this program except one are scheduled to increase in 1989: materials sciences (7 percent to $135 million); chemical sciences (6 percent to $93 million); applied mathematical sciences (1 percent to $43 million); engineering and geosciences (7 percent to $33 million); energy biosciences (3 percent to $21 million); and advanced energy projects (2 percent to $15 million).

A newly-created program entitled, basic research user facilities (BRUF), was established in the 1989 budget. The BRUF program includes R&D activities previously included within the basic energy sciences under R&D operations of major national user facilities. The method of presenting this funding separately in the budget will provides a clearer picture of each of the activities carried out within the basic energy sciences. Funding for the BRUF program is expected to decline slightly between 1988 and 1989.

University research support shows a 14-percent decrease to $16 million in 1989. University research instrumentation is scheduled to remain unchanged at $5 million. These two programs are the primary mechanisms used by DOE to strengthen the institutional capabilities of universities and colleges in contributing to the agency's long-range R&D effort.

Energy research analysis shows a 3-percent increase to $4 million in 1989. This program provides the capability for independent technical assessments of DOE research programs to be undertaken. This program is necessary to better determine priority research needs and to provide an independent view of the overall direction that future R&D efforts should take.

R&D budget authority for supporting research and technical analysis
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$388	$441	$455
Basic energy sciences	366	414	431
Materials sciences	119	126	135
Chemical sciences	79	88	93
Basic research user facilities	67	87	86
Applied mathematical sciences	38	42	43
Engineering and geosciences	29	31	33
Energy biosciences	16	20	21
Advanced energy projects	13	14	15
Program direction	4	5	5
University research support	16	18	16
University research instrumentation	5	5	5
Energy research analysis	2	4	4

SOURCE: National Science Foundation, SRS

Magnetic fusion

The R&D budget authority for magnetic fusion shows an increase of 6 percent, or $19 million, to $317 million in 1989, primarily due to increases in the confinement systems program. The long-term need for magnetic fusion as an energy supply system continues to be strong because it is a source that is secure and environmentally acceptable.

The 1989 budget request for magnetic fusion continues supporting the development of fusion power as a future energy option and provides funding for the support of future initiatives on international cooperation. Research efforts will continue for the Compact Ignition Tokamak, and the International Thermonuclear Experimental Reactor, an international prototype fusion reactor.

Confinement systems, the largest program within magnetic fusion, is expected to increase 11 percent, or $17 million, to $176 million. This increase is due to an 11-percent increase in toroidal confinement systems, which is one of the two base types of magnetic fusion currently being pursued. The second base technology is mirror confinement, which shows a proposed decrease of 17 percent, or $1 million, to $3 million in 1989.

Applied plasma physics is scheduled to increase 5 percent, or $3 million, to $78 million. These funds will provide for a strong base of plasma research, as well as advances in advanced fusion concepts.

The development and technology program shows a 3-percent, or $2 million, decrease to $54 million in 1989. The reductions are primarily in funding plasma technologies and fusion systems analysis. The fusion technologies program shows a 4-percent increase to $23 million.

R&D budget authority for magnetic fusion

[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$315	$298	$317
Confinement systems	185	159	176
Toroidal confinement systems	166	155	173
Mirror confinement systems	19	4	3
Applied plasma physics	75	75	78
Advanced fusion concepts	23	22	25
Fusion plasma theory	18	19	19
National MFE computer network	18	18	18
Experimental plasma research	15	16	16
Development and technology	51	56	54
Fusion technologies	20	22	23
Plasma technologies	20	24	21
Fusion systems analysis	11	11	10
Planning and projects	1	5	5
Program direction	4	5	5

SOURCE: National Science Foundation, SRS

Nuclear fission

R&D budget authority for nuclear fission is scheduled to decline 10 percent, or $31 million to $293 million in 1989, with reductions expected in several programs. The R&D programs in nuclear fission support civilian reactor development to assist industry in its efforts to develop nuclear power into an economically and environmentally acceptable source of energy, and to meet long-term national interests, by maintaining an influence in the international marketplace and in the development of nuclear nonproliferation policy.

Nuclear energy R&D is expected to decrease $26 million, or 8 percent, to $293 million. With the exception of space and defense power systems and advanced nuclear systems, most of the R&D programs within nuclear energy are scheduled for budget reductions in 1989.

The test facilities program is expected to receive an 8-percent decrease, or $9 million, to $97 million. The reduction results from anticipated increased cost sharing from users of the test facilities, and from facilities consolidation and program restructuring.

Space and defense power systems, the program with the largest increase is scheduled to grow 19 percent reaching $75 million. This program is designed to develop nuclear power sources to support emerging Department of Defense requirements for a variety of terrestrial and space missions.

The advanced reactor R&D program is expected to decrease $29 million, or 32 percent, to $60 million. This program will continue funding, at a reduced level, research on alternatives to current reactor systems by identifying and advancing promising innovative reactor concepts.

The light water reactors R&D effort is scheduled to decrease 16 percent to $27 million. This program supports industry-led efforts to revitalize light water technology as a vital component of the national energy base to meet electricity demands.

Advanced nuclear systems funding is expected to increase 25 percent to $25 million. This program develops and maintains the national capability to produce nuclear radioisotopic power sources for civilian and military applications jointly with other government agencies. The increase in funding for 1989 is expected to emphasize safety-related research efforts.

No funds are proposed in 1989 for the remedial action and waste technology programs and the civilian radioactive waste program.

R&D budget authority for nuclear fission
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$310	$324	$293
Nuclear energy R&D	303	319	293
Test facilities	120	106	97
Space and defense power systems	38	63	75
Advanced reactor R&D	73	89	60
Light water reactors	34	32	27
Advanced nuclear systems	17	20	25
Water cooled breeder reactor	14	-	-
Program direction	8	9	8
Remedial action and waste technology	6	5	-
Civilian radioactive waste	1	-	-

SOURCE: National Science Foundation, SRS

Biological and environmental research

Biological and environmental research is expected to increase 15 percent, or $31 million, to $237 million in 1989. This program represents the Nation's only long-term research effort specifically focused on energy-related health and environmental issues. This program seeks to identify, understand, and anticipate the long-term health and environmental consequences of energy development and use; and to use the Department of Energy's scientific and technological capabilities to solve major scientific problems in medicine and biology.

Funding in 1989 will emphasize research on developing technologies for mapping the entire human genome and the enhancement of the research efforts to reduce uncertainties concerning the effects of increased carbon dioxide in the atmosphere. Research will also focus on the health effects of radon.

Health effects activities are scheduled for a 10-percent, or $6 million, increase in 1989 to $71 million. This research activity develops a broad and scientifically sound data base for evaluating the potential adverse health effects that could result from exposures to radiation and chemical agents most relevant to DOE programs.

Increased emphasis in 1989 will be on general life sciences research, which is expected to increase 28 percent, or $11 million, to $51 million. This activity contributes to the base of fundamental biological knowledge that is required for the effective study and interpretation of energy-related health effects.

Research activities for environmental processes and effects are scheduled for a 26-percent, or $9 million increase to $41 million. This research activity examines the release of agents from an energy source, to understand their transport and transformation through atmospheric, terrestrial, and marine media in order to estimate the subsequent exposure to humans and the environment.

Increases are also scheduled for source and dose determination, which is expected to increase 10 percent, or $2 million, to $18 million and carbon dioxide research which is expected to increase 27 percent to $18 million.

Nuclear medicine research will remain unchanged at $35 million.

R&D budget authority for biological and environmental research
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$177	$205	$237
Health effects	60	64	71
General life sciences	33	40	51
Environmental processes and effects	32	32	41
Nuclear medicine	22	35	35
Source and dose determination	14	16	18
Carbon dioxide research	13	14	18
Program direction	4	4	4

SOURCE: National Science Foundation, SRS

Solar and other renewable energy

R&D budget authority for solar energy is expected to decrease 23 percent, or $22 million, to $74 million in 1989. The solar energy R&D program is designed to support generic and long range research on a variety of alternative energy technologies that offer a diversification of supply that can satisfy energy demands in all common forms used by the economy--electricity, heat, and gaseous, liquid, and solid fuels. The main research areas being pursued at universities and national laboratories are materials sciences, aerodynamic/fluid dynamic modeling, and thermodynamic cycles. Photovoltaic energy systems, which is the largest solar energy program, will receive $23 million in 1989. This is a 33-percent, or $11 million, reduction from the 1988 level. This program supports research that involves the direct conversion of sunlight into electricity. Solar thermal energy systems, will receive a 13-percent reduction in 1989, to $15 million. The objective of this program is to advance the engineering and scientific base from which private industry can develop solar thermal power production options. This program funds research in the utilization of mirrors and other concentrators to produce steam from sunlight. Biofuels energy systems, is scheduled for a $7 million, or 39-percent, reduction to $10 million in 1989. Research funding emphasizes improved methods of growing and converting renewable organic materials into directly usable liquid and gaseous fuels. Wind energy systems, is expected to increase by 2 percent to $8 million in 1989, and research will focus on the understanding of fundamental atmospheric processes and their effects on wind turbines.

Geothermal energy R&D programs are expected to decrease 25 percent, or $5 million, to $16 million in 1989. The objective of this program is to assist the private sector in developing a technology base that will be used for future commercial geothermal development. The three major areas within the geothermal energy program are expected to receive reduced funding. Hot dry rock research is scheduled for a 40-percent reduction to $4 million in 1989; geopressured research is scheduled for a 42-percent reduction to $3 million; and funding for reservoir technology research is expected to decrease 44 percent to $3 million.

R&D budget authority for electric energy systems and energy storage systems is scheduled to decrease 12 percent, to $26 million in 1989. These programs support a variety of research activities to develop a technology base for solving mid-to-long term problems in electric energy transmission and distribution and integrating renewable energy resources into the Nation's utility network. Emphasis in 1989 is on potential electrical utility applications of the new high temperature superconducting materials. Electric energy systems is scheduled for a 16-percent increase in 1989 to $18 million. Energy storage systems budget authority is 42 percent, or $6 million, less than the $15 million requested in 1988.

R&D budget authority for solar and other renewable energy
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$170	$146	$115
Solar	121	95	74
Photovoltaic energy systems	39	35	23
Solar thermal energy systems	23	17	15
Biofuels energy systems	23	17	10
Wind energy systems	16	8	8
Solar building energy systems	6	5	5
Ocean energy systems	4	4	3
Solar technology transfer	2	3	2
Resource assessment	1	1	1
International solar energy	1	1	1
Program direction and support	5	5	5
Electric energy and energy storage systems	28	30	26
Electric energy systems	11	15	18
Energy storage systems	17	15	8
Geothermal	21	21	16
Hot dry rock research	8	6	4
Geopressured research	4	5	3
Reservoir technology	5	5	3
Hard rock penetration research	1	2	2
Conversion technology	1	2	2
Magma energy	(a)	1	2
Program direction	1	1	1
Hydropower	(a)	-	-

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Uranium enrichment

Uranium enrichment is scheduled for a $10-million, or 17-percent, increase in funding in 1989. The goal of this program is to conduct research in support of the U.S. Government requirements to meet domestic and foreign uranium enrichment services in the most economical, reliable, safe, secure, and environmentally acceptable manner possible. Uranium enrichment R&D activities are all conducted under the Atomic Vapor Laser Isotope Separation (AVLIS) program. A main objective of this program is assure long-term price competitiveness of the United States by having an advanced technology option available to all interested institutions that can enrich uranium at a cost significantly less than gaseous diffusion plants and foreign competitors.

Uranium separation/processing demonstration is expected to increase 17 percent to $37 million in 1989. Major R&D efforts include activities at Lawrence Livermore Laboratory's Mars facility that will focus on configuration modifications and operational improvements, and the beginning of the design stage for a one-quarter scale prototype electrolytic cell to make uranium metal feed material for the AVLIS process.

Laser demonstration is scheduled to increase 11 percent, or $3 million, to $30 million in 1989. This program will continue work in three major areas: (1) continued operation of the first two laser corridors, (2) the beginning of design stage for the third and fourth corridors of lasers to be installed in 1990, and (3) the development of improved copper vapor laser components.

R&D budget authority for uranium enrichment
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$72	$74	$84
Atomic Vapor Laser Isotope Separation	72	74	84
Uranium separation/processing demonstration	30	32	37
Laser demonstration	34	27	30
Technology transfer and analysis	1	1	1
Integration and support	7	14	16

SOURCE: National Science Foundation, SRS

Energy conservation

Energy conservation is scheduled for a reduction of $58 million, or 42 percent, to $79 million in 1989. This program supports research in areas of energy conservation where new knowledge can expand the technology base which will assist the private sector in developing technological means to use energy economically. The program supports activities ranging from basic research in universities and national laboratories to applied research and development in industrial firms.

Transportation R&D funding for energy conservation is proposed at $28 million, 43 percent, or $22 million less than in 1988. All of the major transportation programs in energy conservation will decrease in 1989. The vehicle propulsion R&D program is expected to receive the largest decline--$10 million, or 59 percent less than the 1988 levels. The electric and hybrid vehicle R&D program and the advanced materials development program will also suffer severe cutbacks in 1989. The remaining programs in transportation focus on research efforts to improve the energy efficiency of vehicle systems.

The 1989 budget request of $19 million for multisector R&D programs is 15 percent less than 1988. The multisector program supports basic research and exploratory development of new concepts that offer increased efficiencies in energy conversion and utilization applications. Funding for the energy conversion and utilization technologies (ECUT) program is scheduled to decrease by $3 million, or 13 percent, to $18 million in 1989. In 1989, technology assessment and transfer is expected to receive $1 million.

Industrial R&D programs are scheduled to decrease by 50 percent to $15 million in 1989. These programs support research and development activities which have the potential to increase energy use efficiency and the use of alternative fuels in private industry. This decline largely results from a 54-percent, or $7 million, decrease in the industrial process efficiency program and funding will amount to $6 million in 1989 R&D budget authority. The waste energy reduction program is scheduled for a 39-percent, or $4 million, reduction to $7 million in 1989. The industrial cogeneration program is scheduled to decrease 80 percent to $1 million.

Buildings and community systems R&D programs show a 58-percent, or $19 million, reduction to $14 million in 1989. All activities within this program, except for the Federal energy management program, are scheduled for reductions in 1989. The technology and consumer products area is scheduled to decrease 59 percent, or $6 million, to $4 million. Building systems research will be reduced by 66 percent to $4 million in 1989. The community systems programs are scheduled for termination in 1989.

R&D budget authority for energy conservation
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$145	$137	$79
Transportation	56	50	28
Advanced materials development	13	13	10
Vehicle propulsion R&D	24	17	7
Electric and hybrid vehicle R&D	14	14	6
High temperature materials laboratory	1	2	2
Alternative fuels utilization	1	1	2
Technology assessment and transfer	1	1	1
Program direction	2	2	1
Multisector	23	23	19
Energy conversion and utilization	21	20	18
Technology assessment and transfer	-	-	1
National appropriate technology	1	1	1
Program direction	1	1	(a)
Industrial	33	30	15
Waste energy reduction	13	11	7
Industrial process efficiency	14	13	6
Industrial cogeneration	5	4	1
Program direction	2	2	2
Buildings and community systems	30	33	14
Technology and consumer products	10	11	4
Building systems	9	10	4
Appliance standards	2	2	2
Technology assessment and transfer	2	3	1
Federal energy management program	1	1	1
Community systems	3	4	-
Program direction	4	3	2
Policy and management	2	2	2

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Nuclear Regulatory Commission

The proposed 1989 request for NRC is $137 million, $26 million, or 23 percent more than in 1988. The Office of Nuclear Regulatory Research has the authority and the responsibility under the Energy Reorganization Act of 1974 to conduct research in support of the nuclear regulatory process. The 1989 budget has been reorganized and includes program titles and definitions that more adequately describe the mission areas of the Nuclear Safety Research program. Primary focus is on the development of a complete and sound base of technical information on basic safety issues as well as complex technical issues. The NRC also provides an independently verified source of safety, health and environmental information. This information is coordinated with data supplied by applicants and licensees to be used as a basis for licensing and regulatory decisions.

Integrity of reactor components funding is expected to increase 36 percent, or $9 million, to $35 million in 1989. This program examines reactor systems and related components to determine whether they perform as designed and that their functional integrity and operability can be maintained over the life of the plant. This program consists of four major program elements: reactor vessel and piping integrity, aging of reactor components, reactor equipment qualification, and seismic and fire protection. The increase in 1989 is for pressure vessel safety irradiation tests and studies associated with pipe cracking, nondestructive examination methods to measure mechanical properties for predictions of materials aging, developing requirements for reinspection of nuclear power plants as a basis for license renewals, and increased work in plant-aging research.

Reactor containment and public protection funding is expected to increase 19 percent to $34 million in 1989. This program is primarily directed towards protecting the public in the unlikely event of a very severe reactor accident. These activities include the siting of nuclear plants away from population centers, the inclusion of specially engineered safety systems designed to prevent failure of the containment, and development of safety systems to limit the quantities of fission products that might be released if the containment were to lose its leak tight integrity. Major subprograms include: radionuclide source terms, reactor containment safety, reactor accident risk analysis, severe accident policy implementation, and radiation protection and health effects. Increased funding in 1989 is for revitalizing the radiation protection and health effects program, accelerating research to determine the probability of containment failure, initiating seismic testing of steel containment models, and severe accident testing in the Canadian nuclear test facility.

Preventing damage to reactor cores research is expected to increase 34 percent to $25 million. This program encompasses the operations of the reactor as a system, including control of power level, maintaining water in the reactor system, core cooling and heat removal and maintaining proper temperatures and pressures. Major subprograms are: plant performance, human performance, reliability of reactor systems, and accident management. Individual activities contributing to this increase are experiments using the multi-loop integral system test facility, studies to develop experimental data for improving scientific models, efforts in human factors research and human error studies, and the support of individual plant examinations.

Resolving safety issues is expected to increase 21 percent to $12 million. This program ensures that resources are directed towards developing the technical and regulatory requirements to protect the health and safety of the public in the generation of electricity and in the manufacturing, processing, transporting, and storing of nuclear fuel. Major subprograms are: generic and unresolved safety issues, standardized and advanced reactors, fuel cycle materials, safeguards research and standards development, and developing and improving regulations. Increases in 1989 funding levels are primarily attributed to the revitalization of human factors research.

R&D budget authority for the Nuclear Regulatory Commission
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$122	$112	$137
Integrity of reactor components	39	26	35
Reactor containment and public protection	30	29	34
Preventing damage to reactor cores	20	19	25
Resolving safety issues	6	10	12
Confirming safety of nuclear waste disposal	5	6	7
Administrative and staff support	23	23	24

SOURCE: National Science Foundation, SRS

Environmental Protection Agency

Energy-related R&D activities within EPA are expected to remain relatively stable at $55 million. All energy R&D activities are performed under the multi-media energy research program. The largest program, acid rain, is expected to remain unchanged at $52 million in 1989. Acid rain research will continue to estimate emissions from man-made sources, better understand atmospheric processes, establish deposition monitoring databases, and quantify aquatic effects, terrestrial effects, and the effects of materials on cultural resources. Research activities in environmental engineering and technology are expected to decrease to $3 million with R&D efforts directed toward the Limestone Injection Multistage Burner (LIMB) control technology program.

R&D budget authority for the energy R&D program of
the Environmental Protection Agency
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$63	$56	$55
Multi-media energy	63	56	55
Acid rain	54	52	52
Environmental engineering and technology	9	4	3
Environmental processes and effects	(a)	-	-

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

TRANSPORTATION

In 1989, transportation R&D funding is proposed at $1.1 billion, 16-percent, or $146 million, higher than in 1988. Transportation R&D funding is categorized into four subfunctions including air, ground, water and other R&D activities and is comprised of R&D programs of the Department of Transportation (DOT) and the aeronautical research and technology programs of the National Aeronautics and Space Administration.

Increases in R&D funding for transportation are primarily attributed to the following:

- An increase of 22 percent, or $136 million, to $747 million in the air transportation R&D programs of NASA. All major programs within aeronautical research and technology and transatmospheric research and technology shared in this increase.

- An increase of 5 percent, or $6 million, in ground transportation to $123 million is proposed for 1989. This proposed increase is the result of additional funding for the R&D programs of the National Highway Traffic Safety Administration.

- An increase of 25 percent, or $2 million, in transportation R&D programs classified under the all other subfunction. Growth is proposed for the R&D programs of the Office of the Secretary (DOT) and the Research and Special Programs Administration (DOT).

R&D budget authority for transportation

[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$908	$918	$1,064
Air transportation	751	774	912
National Aeronautics and Space Administration	600	611	747
Aeronautical research and technology	574	579	698
Transatmospheric research and technology	26	32	50
Federal Aviation Administration (DOT)	151	163	165
Air traffic control	77	93	83
Advanced computer	23	18	24
Aircraft safety	23	19	22
Aviation weather	7	15	15
Operations development	9	10	10
Aviation medicine	4	4	5
Navigation	6	3	3
Environment	2	2	2
Ground transportation (DOT)	128	117	123
Federal Highway Administration	83	82	82
National Highway Traffic Safety Administration	28	24	30
Federal Railroad Administration	10	9	9
Urban Mass Transportation Administration	8	2	2
Water transportation (DOT)	24	19	19
Coast Guard	20	19	19
Maritime Administration	4	-	-
Other transportation (DOT)	5	8	10
Office of the Secretary	3	5	7
Research and Special Programs Administration	2	3	3

SOURCE: National Science Foundation, SRS

Air transportation

Air transportation is expected to increase to $912 million, $138 million, or 18 percent more than in 1988. NASA's aeronautical research and technology program will increase by $118 million to $698 million in 1989. The research and technology base programs will increase 34 percent, or $68 million, to $268 million, with all of the individual subprograms gaining funding in 1989. Increased funding is proposed for propulsion and power research, which is scheduled to grow $23 million, or 65 percent, to $60 million. Efforts will focus on the fundamental understanding of stationary and rotating component flow fields. The largest growth in funding is proposed for controls and guidance research which is expected to rise $14 million, or 81 percent, to $30 million. The emphasis will be on the evaluation of flight takeoff and landing performance monitoring, high-speed rollout and turnoff capacity improvements, and navigation systems for reducing airport congestion and delays.

The systems technology programs are scheduled to rise 29 percent to $85 million, with most of the increase taking place in materials and structures, which is proposed to grow $18 million to $25 million. The objective of this program is to develop advanced materials and structural concepts for future advanced aircraft propulsion systems and primary structures. The increase in 1989 is a result of the transfer of and increased support for programs previously classified under advanced propulsion.

In 1989, the transatmospheric research and technology program, will receive an increase of $17 million, or 54 percent more than 1988 funding levels. The objective of this program, supported in conjunction with DOD, is to develop the technology base for a national aerospace plane.

The Federal Aviation Administration (FAA) R&D programs are scheduled for an increase of 1 percent, or $2 million, to $165 million in 1989. The funding level is consistent with the needs of the National Airspace System Plan. Major initiatives include enhancing the capability of a wide range of radar systems, continuing support for the Traffic Alert and Collision Avoidance System, increasing systems and airport capacity, continuing efforts for Advanced Traffic Management and Automated Enroute Traffic Control, development of radars for detection and tracking of severe weather, and continuing emphasis on aviation security. The air traffic control program is expected to decrease 10 percent from $93 million in 1988 to $83 million in 1989. The advanced computer program is proposed to increase, primarily as a result of the transfer of R&D programs previously classified under air traffic control. Smaller increases are also proposed for the aircraft safety, aviation medicine, navigation, and environment programs.

R&D budget authority for the air transportation programs of the National Aeronautics and Space Administration
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$600	$611	$747
Aeronautical research and technology	574	579	698
Research and technology base	229	200	268
Propulsion and power	35	36	60
Applied aerodynamics	47	42	55
Materials and structures	30	30	34
Controls and guidance	19	17	30
Flight systems	20	20	25
Fluid and thermal physics	33	20	23
Information sciences	20	15	20
Human factors	20	16	17
Systems analysis	5	4	5
Systems technology programs	87	66	85
Numerical aerodynamic simulation	25	31	35
Materials and structures	-	7	25
Advanced propulsion	24	14	12
High-performance	22	10	9
Rotorcraft	16	4	4
Research and program management	258	314	344
Transatmospheric research and technology	26	32	50

SOURCE: National Science Foundation, SRS

Ground transportation

R&D support for ground transportation is expected to increase approximately 5 percent, or $6 million, to $123 million in 1989. This growth is primarily for proposed increases in the R&D programs of the National Traffic Highway Safety Administration. In 1989, increases are proposed for crash avoidance research, highway safety research, the National Occupant Protection Program, enforcement and emergency services, and the National Driver Register. Proposed funding for the three other agencies with R&D activities in ground transportation, Federal Highway Administration, Federal Railroad Administration, and the Urban Mass Transportation Administration is the same as in 1988.

Water transportation

Water transportation R&D activities are expected to remain unchanged--at $19 million--from funding levels proposed for 1988. The U.S. Coast Guard is scheduled to receive $19 million and the Maritime Administration is proposed to receive no funding for 1989. The R&D programs within the Maritime Administration have been phased out effective with the 1988 budget.

Other transportation

This category includes R&D programs that are not classified under air, ground, or water transportation. The Office of the Secretary of Transportation and the Research and Special Programs Administration (RSPA) account for all of the activities within this subfunction. The Office of the Secretary is proposed to increase funding for R&D activities, 34 percent, or $2 million, to $7 million. R&D efforts will focus on broad-based policy research on domestic and international transportation issues and research in support of licensing and promoting expendable launch vehicles. RSPA R&D activities are proposed to increase 8 percent to $3 million. Areas of R&D emphasis will include hazardous materials, pipeline safety, radio-navigation, transportation statistics, and emergency transportation.

NATURAL RESOURCES AND ENVIRONMENT

Funding for 1989 R&D programs on natural resources and environment is expected to be $1.1 billion, a reduction of 9 percent, or $102 million, below the 1988 level. This function is comprised of selected programs from a number of Federal agencies including the Department of the Interior, the Environmental Protection Agency, the Department of Commerce, and the Department of Agriculture. Research and development activities that fall within this function are viewed as contributing towards the management of public lands and other natural resources for their preservation, conservation and economic development, as well as encouraging increased knowledge and understanding of the environment.

Reduced R&D support for natural resources and environment can be attributed to decreases in the following activities:

- A 20-percent, or $121 million, reduction in support for R&D programs that are classified in the other natural resources category. This decrease is primarily attributed to a reduction of $102 million in the R&D programs of the National Oceanic and Atmospheric Administration to a total of $180 million in 1989.
- A $7 million, or 5-percent, decline in conservation and land management to $135 million, largely attributed to a decrease in the R&D programs of the Forest Service.
- A 2-percent, or $2 million, reduction in 1989 R&D funding for recreational resources, to a total of $76 million.

Elements of proposed R&D funding increases that will partially offset decreased program levels for 1989 include the following:

- A $23 million, or 8-percent increase for the pollution control and abatement programs of the Environmental Protection Agency to $319 million.
- A 13-percent, or $5 million, increase in support for water resources to $43 million, largely related to increased funding levels for the Bureau of Reclamation (Interior) and the Army Corps of Engineers (DOD).

R&D budget authority for natural resources and environment
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$1,133	$1,163	$1,061
Pollution control and abatement (EPA)	284	296	319
Conservation and land management	132	141	135
Forest Service (USDA)	127	136	129
Department of Interior	6	6	5
Recreational resources	72	78	76
Fish and Wildlife Service (Interior)	54	59	55
National Park Service (Interior)	18	19	21
Water resources	40	38	43
Corps of Engineers (DOD)	30	33	36
Bureau of Reclamation (Interior)	10	5	7
Other natural resources	603	609	488
Geological Survey (Interior)	227	236	223
National Oceanic and Atmospheric Administration (Commerce)	289	282	180
Bureau of Mines (Interior)	87	92	86

SOURCE: National Science Foundation, SRS

Pollution control and abatement

The 1989 budget authority request for the pollution control and abatement programs of the Environmental Protection Agency is $319 million. This represents an 8-percent, or $23 million increase over the 1988 level. The goals of the research program at EPA are to develop the scientific data necessary for determining the most cost effective and environmentally safe means of achieving environmental results; to provide the necessary scientific data in support of the statutory and regulatory responsibilities; and to further the state of knowledge on environmental issues.

Major emphases in the 1989 budget include: efforts to understand the causes and effects of stratospheric ozone depletion; evaluating control technologies to provide cost effective solutions to environmental problems; reducing uncertainties in risk assessments; and promoting technology transfer activities to enhance program performance.

The air quality research program is scheduled to increase by $7 million, or 10 percent, to $73 million in 1989. Research efforts will support a significant expansion in stratospheric ozone depletion research, an analysis of the effects of global climate change, and an assessment of the environmental risks of indoor air pollutants. Research efforts will also support revisions to the National Ambient Air Quality Standards and the air toxics program.

Superfund and Lust trust fund research programs are expected to increase $8 million, or 14 percent, to $67 million in 1989. The expansion of the Superfund program will provide technical support for conducting cleanups and enforcement actions at Superfund sites. In 1989, a new Superfund initiative will be undertaken to evaluate biological treatment systems which may reduce the costs of cleaning up Superfund sites. Research efforts continue in supporting commercialization techniques through the Superfund Innovative Technology Evaluation (SITE) Program.

The Leaking Underground Storage Tanks (LUST) Program provides technical assistance to the EPA's Office of Underground Storage Tanks and will focus on developing low-cost approaches for assessing site contamination and evaluating remedial technologies.

Hazardous waste research funding is scheduled to decrease by 8 percent, or $3 million, to $41 million in 1989. The reduction in funding is attributed to the completion of support for an outside research center and the transfer of resources to the technology evaluation program under the Superfund program. Research will continue on alternatives to conventional means of disposing and destroying wastes and on methods of controlling emissions from municipal waste combustors.

Interdisciplinary research funding is expected to increase $7 million, or 27 percent, to $34 million in 1989. This subactivity consists of those programs which cut across all other R&D activities. The increase is attributed to a new program on reducing uncertainties in risk assessments. Research efforts include uniform risk assessment, technical information and liaison, regulatory support, quality assurance management, and exploratory research.

Toxic substances R&D funding is expected to remain virtually unchanged from the 1988 level of $27 million. Increased emphasis in 1989 will be placed on evaluating asbestos sampling protocols and control technologies. Research efforts will continue in the areas of test methods development and evaluation, environmental engineering and technology, and biotechnology.

The water quality research funding level--at $25 million--is expected to remain essentially unchanged from the 1988 level. Research in water quality supports the mandates of the 1987 Clean Water Act Amendments and includes the gathering of scientific data to help States develop site-specific standards and conduct use-attainability analyses. Research is also conducted on evaluating impacts of ocean disposal practices, understanding the Great Lakes ecosystems, and developing responsive and scientifically valid estuarine programs. The program in 1989 will focus on the development of scientific data to support sludge regulations as well as provide health and environmental information on toxic chemicals of concern.

In 1989, drinking water research activities will remain at the 1988 level of $22 million. Research within this program provides health assessment information to support the development of new regulations to control drinking water contaminants and to assist States in ascertaining the causes of waterborne infectious disease outbreaks to determine the hazard to humans from exposure to these diseases through drinking water. Emphasis in 1989 will be placed on identifying and characterizing the health impact of disinfectants and their by-products, and on more effective restoration techniques to clean up contaminated aquifers.

Pesticides research funding is scheduled to increase 12 percent to $14 million in 1989. Federal laws require the regulation of pesticide use to avoid unreasonable adverse effects to public health and the environment. Research activities will focus on understanding how pesticides interact with human activities and the environment. Research will also be focused on determining the health and environmental effects of genetically-engineered pesticides.

Radiation research funding is expected to increase $1 million, or 36 percent, to $4 million in 1989. The radiation research program provides Federal, regional, State, and local officials with scientifically credible data, methods, and assessments required to determine and control public exposure to radioactive materials in the environment. Emphasis in 1989 will be on increasing the number of demonstrations of techniques for reducing exposure to indoor radon gas in new and existing housing structures.

R&D budget authority for pollution control and abatement
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$284	$296	$319
Environmental Protection Agency			
Air quality	63	66	72
Superfund/Lust trust fund	39	59	67
Hazardous waste	50	45	41
Interdisciplinary	26	27	34
Toxic substances	31	27	27
Water quality	25	25	25
Drinking water	23	22	22
Pesticides	13	13	14
Radiation	3	3	4
Abatement control and compliance	(a)	-	-
Program management and support	11	10	12

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Conservation and land management

Funding for conservation and land management is proposed at $135 million in 1989 which is $7 million, or 5-percent, below the 1988 level. The Forest Service, accounting for 96 percent of the 1989 funding, is scheduled for a 5-percent reduction. This decrease results partially from the elimination of the special competitive grants programs. The Forest Service R&D programs provide land managers and owners with scientific information on the management of timber, forage, wildlife, recreation, and watershed to provide for the continued use and productivity of the Nation's forests and related rangelands. Current areas of research include genetics, silviculture and timber management, watershed management, wildlife, range and fish habitats, recreation, protection of forest resources from fire and forest pests, forest utilization and harvesting, economics of forest commodity production, processing and distribution, and forest inventory and analysis.

R&D budget authority for conservation and land management
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$132	$141	$135
Forest Service (USDA)	127	136	129
Forest protection	31	31	33
Forest and environmental research	28	29	29
Timber management	24	27	25
Resource analysis	25	25	23
Forest products and harvesting research	19	20	19
Special competitive grants	-	3	-
Department of Interior	6	6	5
Bureau of Lands Management	4	4	3
Minerals Management Service	1	1	1
Office of Surface Mining and Reclamation	1	1	1

SOURCE: National Science Foundation, SRS

Recreational resources

Overall support for recreational resources R&D programs will decrease 2 percent, or $2 million, to $76 million in 1989. The Fish and Wildlife Service (Interior), which funds almost three-quarters of the R&D activities, is expected to decrease 7 percent, or $4 million, to $55 million. The Fish and Wildlife Service supports research and development relating to the habitats of waterfowl, migratory and non-migratory birds and mammals; the status and distribution of endangered and threatened species; the impact of broadscale environmental changes on fish and wildlife populations and habitat; and on diseases of freshwater and anadromous fish. The National Park Service (Interior) will expand its R&D activities by 11 percent, or $2 million, to $21 million in 1989. Research programs will focus on protecting and preserving the natural and cultural resources of the National Parks.

R&D budget authority for recreational resources
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$72	$78	$76
Fish and Wildlife Service (Interior)	54	59	55
Fish and wildlife research and operations	44	48	44
Wildlife resources	12	15	13
Habitat/contaminants	13	12	12
Fishery resources	12	13	12
Endangered species	5	5	5
Research maintenance	2	2	2
Cooperative research units	5	6	6
Technical development	6	6	5
National Park Service (Interior)	18	19	21

SOURCE: National Science Foundation, SRS

Water resources

The 1989 budget request for water resources R&D activities is $43 million--an increase of $5 million, or 13 percent, from the 1988 level. This growth is from the R&D programs of the Army Corps of Engineers (DOD) and Bureau of Reclamation (Interior). R&D activities of the Army Corps of Engineers are expected to increase 8 percent, or $3 million, to $36 million. The growth for 1989 results in the full funding of the dredging research program and increased funding for the general investigations R&D program within which are new actvities in coastal geology, and geotechnology and water source interrelationships. Efforts will focus on dam safety, protection of coastal areas, navigation, flood control, ice and its effects on navigation and flooding, environmental impacts in wetlands, effects of contaminant mobility and toxic substances in dredged materials. A $2 million increase in R&D funding for the Bureau of Reclamation is due to the scheduled increase in funding for the atmospheric water program in 1989.

R&D budget authority for water resources
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$40	$38	$43
Army Corps of Engineers (DOD)	30	33	36
R&D construction operations and maintenance	15	17	17
Coastal engineering	5	5	6
Flood control and navigation	4	4	5
Materials research	2	3	3
Water resources planning studies	2	1	2
Environmental quality	2	2	2
Surveying and satellite applications	1	1	1
Coastal engineering research board	(a)	(a)	(a)
Bureau of Reclamation (Interior)	10	5	7

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Other natural resources

This subfunction includes all programs that are not classifiable under the other groups in the natural resources and environment function. This subfunction represents about one-half of the funding for natural resources and the environment, and is comprised of the R&D programs of three agencies: the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and the Bureau of Mines. These programs are scheduled for a 20-percent, or $121 million, decrease in 1989 to $488 million.

R&D programs of the Geological Survey (Interior) are scheduled to decrease 5 percent, or $13 million, to $223 million. These R&D programs provide scientific data and information on the Nation's water, land, and mineral resources. In 1989, most of the decrease in funding is expected to occur in the national water resources research and information systems program, which is proposed to decline 10 percent, or $8 million, to $74 million. The geologic and mineral resource surveys and mapping program is expected to decrease 4 percent, or $6 million, to $131 million. The national mapping geography and survey program is expected to increase 6 percent, or $1 million, to $18 million.

R&D budget authority for the National Oceanic and Atmospheric Administration (Commerce) is scheduled to decrease 36 percent, or $102 million, to $180 million. These decreases reflect the Administration's policy of reduced support in areas deemed more appropriately the responsibility of state and local governments or private industry. The proposals include a termination of the following programs: Seafloor Spreading Center Research, National Undersea Research Program, Saltonstall/Kennedy grant programs, National Sea Grant College Program, and some programs of the National Marine Fisheries Service. The National Weather Service is expected to decrease its R&D funding, with most of the decline attributed to the elimination of the Automated Weather Interactive Processing System (AWIPS).

The Bureau of Mines (Interior) R&D programs are expected to decrease 7 percent, or $6 million, to $86 million in 1989. The Bureau of Mines conducts research to improve understanding of the principles of mining and minerals processing and to reduce associated health hazards. This decrease is the result of proposed reductions in projects which are considered more appropriate for support by non-Federal sources.

R&D budget authority for other natural resources
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$603	$609	$488
U.S. Geologic Survey (Interior)	227	236	223
Geologic and mineral resource surveys and mapping	132	137	131
Geologic hazards surveys	37	38	35
Mineral resource surveys	32	33	33
Offshore geologic surveys	22	23	25
Geologic framework and processes	22	25	21
Energy geologic surveys	18	19	16
Water resources investigations	78	82	74
National water resources and research and information systems	78	82	74
Federal program	48	50	48
Federal/State cooperative program	21	23	22
State programs	9	9	5
National mapping, geography and survey	17	17	18
National Oceanic and Atmospheric Administration (Commerce)	289	282	180
Operations, research and facilities	282	272	180
Oceanic and atmospheric research	96	93	74
National Marine Fisheries Services	87	94	45
National Weather Service	41	30	11
National Oceans Service	17	16	10
National Environmental Satellite Data Information Service	9	9	9
Program support	33	31	31
Fishery products promotion and development	7	9	-
Bureau of Mines (Interior)	87	92	86

SOURCE: National Science Foundation, SRS

AGRICULTURE

All R&D activities within this function are conducted by the Department of Agriculture (USDA). The Department of Agriculture supports research and development in several programs and disciplines to ensure the continued high productivity of U.S. agriculture.

The proposed R&D budget authority for agriculture is $850 million in 1989, compared to $876 million in 1988. The 3-percent decline is attributable to a $40 million decrease proposed for the Cooperative State Research Service, resulting from scheduled reductions or eliminations that include:

- The special grants program is proposed to decrease by $41 million to $6 million in 1989, as a result of the elimination of several grants activities.
- The pest science and the animal health and disease research programs, which together total an estimated $8 million in 1988, are proposed for elimination in 1989.

R&D funding for the Agricultural Research Service is scheduled to increase by 3 percent, or $16 million, over 1988 to a total of $524 million. The increase is distributed over the following programs:

- An additional $6 million over the 1988 level to $64 million is expected for research on soil and water conservation.
- An increase of $5 million to $106 million is proposed for research on commodity conversion and delivery.
- A $3 million increase to $207 million is proposed for research on plant sciences.
- A $2 million increase to $92 million is scheduled for research on animal sciences.

R&D budget authority for agriculture (USDA)
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$822	$876	$850
Agricultural Research Service	479	508	524
Research on plant sciences	187	203	207
Research on commodity conversion and delivery	98	101	106
Research on animal sciences	87	90	92
Research on soil & water conservation	58	58	64
Human nutrition research	39	43	43
Integration of agricultural systems	11	12	12
Cooperative State Research Service	274	295	255
Payments under the Hatch Act	149	156	156
Competitive research grants	41	42	55
Biotechnology	19	19	22
Plant science	12	12	12
Animal science	4	6	7
Human nutrition	2	2	3
Pest science	3	3	-
Payments to 1890 colleges and Tuskegee Institute	22	23	25
Cooperative forestry research	12	18	13
Special grants	36	47	6
Animal health and disease research	5	5	-
Forestry Competitive Grants	6	-	-
Administration	3	4	1
Economic Research Service	45	48	50
Human Nutrition Information Service	7	9	9
Animal & Plant Health Inspection Service	5	5	5
National Agricultural Statistics Service	3	4	4
Agricultural Cooperative Service	3	3	1
Office of Transportation	1	1	1
Federal Grain Inspection Service	1	1	1
Office of International Cooperation and Development	3	2	-
Agricultural Marketing Service	2	2	-

Source: National Science Foundation, SRS

Agricultural Research Service

The 1989 budget includes $524 million for the Agricultural Research Service (ARS) R&D activities, an increase of $16 million, or 3 percent, over 1988. Emphasis will continue to be placed on basic research on germplasm and on biotechnology to augment profitability and competitiveness in U.S. agriculture. Plant sciences, which is the largest ARS R&D program, is proposed to increase by $4 million to $207 million. A $5 million increase is expected for the commodity conversion and delivery program. An increase of $2 million to $92 million is expected for R&D activities within the research on animal sciences program. The research on soil and water conservation program is scheduled to increase by $6 million to $64 million in 1989. The human nutrition research and integration of agricultural systems programs are both expected to remain at 1988 levels.

Cooperative State Research Service

Budget authority for the Cooperative State Research Service (CSRS) is expected to decrease by $40 million, or 13 percent, to $255 million in 1989. R&D funding for payments under the Hatch Act, which accounts for 61 percent of CSRS funding, is expected to remain at the 1988 level of $156 million. The competitive research grants program is expected to increase by $12 million, or 29 percent, to $55 million in 1989. The increase in the competitive research grants program will support grants at the 1988 level or slightly above, except for the proposed elimination of pest science. R&D funding for payments to the "1890" colleges and Tuskegee Institute is expected to increase by 9 percent to $25 million in 1989. In addition, elimination is proposed for several grants within the special grants program, animal health and disease research, and forestry competitive grants.

Economic Research Service

The Economic Research Service (ERS) is scheduled to receive $50 million for research, an increase of $2 million, or 3 percent, over 1988. The increase in funds is distributed among all ERS programs, which include agriculture and rural economy, agriculture and trade analysis, commodity economics, and resources and technology.

Other departmental programs

R&D programs within the Office of International Cooperations and Development and the Agricultural Marketing Service are scheduled for elimination in 1989. All other agriculture programs are expected to remain at 1988 funding levels except for the Agicultural Cooperative Service, which is down $2 million to $1 million in 1989.

EDUCATION, TRAINING, EMPLOYMENT, AND SOCIAL SERVICES

In 1989, R&D budget authority for education, training, employment, and social services of $295 million is $4 million, or 1 percent, more than in 1988. This function is comprised of selected programs of the Department of Education, the Smithsonian Institution, the Office of Human Development Services of the Department of Health and Human Services, and the Department of Labor.

Increased R&D support for education, training, employment and social services can be attributed to proposed increases in the following:

- A 3-percent, or $4 million, increase in support for research and general education aids to $173 million.

Elements of proposed R&D funding that will remain level in 1989 include the following:

- R&D support for social services will remain unchanged at $104 million.
- R&D support for training and employment will remain unchanged at $7 million.
- R&D support for other labor services will remain virtually unchanged at $11 million.

R&D budget authority for education, training, employment, and social services
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$267	$290	$295
Research and general education aids	146	168	173
Department of Education	72	89	93
Education and research statistics	28	26	29
Vocational and adult education	9	25	23
Education for the handicapped: special purpose funds	22	21	21
Chapter 1 evaluation and technical assistance	2	4	6
Special institutions	4	4	4
Bilingual education	4	3	3
Chapter 2 secretary's discretional fund	-	1	3
International education in foreign language studies	1	1	1
Science and mathematics programs of national significance	1	3	1
Library research and demonstrations	(a)	(a)	1
Drug-free schools and communities national program	1	1	1
Fund for the improvement of postsecondary education	(a)	(a)	(a)
Smithsonian Institution	74	79	80
Social services	101	104	104
Rehabilitation services and handicapped research (Education)	51	52	52
Human Development Services (HHS)	50	51	51
Training and employment	6	7	7
Employment and Training Adm. (Labor)	6	7	7
Other labor services (Labor)	14	11	11
Bureau of Labor Statistics	7	7	7
Departmental management	6	3	3
Pension Welfare Benefits Program	1	1	1
Bureau of Labor-Management Relations and Competitive Programs	(a)	(a)	(a)
Employment Standards Administration	1	(a)	(a)

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Research and general education aids

The programs under this category, account for almost 60 percent of the 1989 funding, and are expected to increase approximately 3 percent, or $4 million, to $173 million. The Department of Education accounts for approximately one-half of the funding within this subfunction. These programs are scheduled to increase 4 percent, or $3 million, to $93 million. Education and research statistics, the largest program within research and general education aids for the Department of Education, is proposed to increase 11 percent, or $3 million, to $29 million. Emphasis in 1989 is directed towards general research and development for improving the quality of education.

The second largest program, adult and vocational education is proposed to decrease 9 percent or $2 million, to $23 million. Despite the overall decline in funding, additional support is proposed for cooperative vocational education and a continuation of support is proposed for adult education demonstration projects and a National Assessment of Vocational Education.

Increases are proposed for other Department of Education programs including, chapter 1, evaluation and technical assistance, chapter 2, secretary's discretionary fund, and library research and demonstration. R&D support for the Smithsonian Institution is proposed to increase by $1 million, or 1 percent, to $80 million. The Smithsonian conducts original scientific research in the fields of biology, geology, oceanography, atmospheric science, anthropology, and history.

Social services

R&D activities classified under social services are comprised of programs within the Department of Education and the Office of Human Development Services (HHS). The rehabilitation services and handicapped research program of the Department of Education is expected to remain unchanged at $52 million. Emphasis in 1989 is on the development of methods and procedures to help severely disabled individuals, and basic research on how knowledge is acquired in severely disabled children. The R&D programs of the Office of Human Development Services within HHS are proposed to remain unchanged at $51 million.

Training and employment

R&D programs, conducted by the Employment and Training Administration (Labor), show a proposed 1989 budget authority of $7 million--unchanged from funding levels for 1988. R&D funding provides support for studies directed to immediate and long-range labor market problems. Major objectives include studies on improving the training and employment system, improving forecasting techniques, and utilizing projections of labor demand and supply, and skill requirements to develop training programs corresponding to the needs of the labor force.

Other labor services

Programs classified under other labor services include all labor-related R&D activities, other than employment and training. R&D support for other labor services is proposed to remain essentially unchanged at $11 million. The largest program within other labor services is supported by the Bureau of Labor Statistics. Resources are primarily assigned towards research designed to maintain the quality, relevance, and timeliness of the Bureau's statistical and analytical output. Research is also directed towards the analysis of the behavior of employment, prices, wages and productivity in the economy.

The second largest R&D program, under other labor services, is classified under Departmental Management but consists of R&D activities supported by three separate offices: (1) the Office of the Assistant Secretary for Policy with an emphasis on exploring the issues of drug abuse in the workplace; (2) the Women's Bureau with support for experimental and demonstration projects that address issues of concern to women and the labor force; and (3) the International Labor Affairs Bureau that conducts research on the impact of changes in U.S. international economic policies on the welfare of U.S. workers.

VETERANS BENEFITS AND SERVICES

All R&D activity within the veterans benefits and services function is funded through the Veterans Administration (VA). In 1989, the R&D budget request for the VA is $206 million, a decrease of almost $4 million, or 2 percent, below 1988.

The VA conducts and administers a program of medical, rehabilitation, and health services research designed to improve the quality and effectiveness of health care for the veteran. Investigator-initiated studies, which comprise three-quarters of medical and prosthetic research, are expected to be $132 million in 1989, an increase of $10 million, or 8 percent, over 1988. Special emphasis within the medical research program is given to Agent Orange, aging, alcoholism, post-traumatic stress, health problems of female veterans and former prisoners of war, and Acquired Immune Deficiency Syndrome (AIDS). Funding for most of the VA's programs is proposed to remain at or increase over 1988 levels, except for both the women's epidemiology study and the investigator-initiated studies (DOD), for which no funds are expected, and the rehabilitation research program, which is expected to decrease by nearly $2 million to a level of $19 million in 1989. Rehabilitation research is directed toward providing health care services for aging and disabled veterans including devices that minimize their disability and enhance the quality of their lives. Health services research is committed to development of an information network that will most effectively generate and transmit information on research findings aimed at bettering health services for veteran patients.

R&D budget authority for veterans benefits and services
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$215	$210	$206
Veterans Administration			
Medical and prosthetic research	187	179	176
Investigator-initiated studies	125	122	132
Career development	16	18	19
Cooperative studies	14	14	15
High priority research	7	3	6
Epidemiology study (CDC)1/	2	3	3
Agent orange studies	2	2	2
Investigator-initiated studies (DOD)2/	20	15	-
Women's epidemiology study	-	2	-
Rehabilitation research	18	21	19
Health services research	8	8	9
Medical administration and miscellaneous operating expenses	2	2	2

1/ Management of the resources associated with this study is the responsibility of the Department of Health and Human Services (HHS) through the Centers for Disease Control (CDC) in Atlanta, Georgia.

2/ In 1987, $20 million was transferred from the Department of Defense (DOD) to the VA for merit review research conducted by the VA in the interest of DOD. In 1988, the Department of Defense will provide $15 million as a reimbursement to conduct additional research projects beneficial to both agencies.

SOURCE: National Science Foundation, SRS

INTERNATIONAL AFFAIRS

All R&D activity within the international affairs function is conducted by the Agency for International Development (AID). The budget authority request for AID in 1989 is $199 million, a decrease of $9 million, or 4 percent below 1988 funding. Emphasis is placed on solving specific problems associated with basic human needs and on social and economic research aimed at understanding the barriers to development. R&D priorities reflect the important development problems faced by the Third World: food and agriculture, health and population, education and human resources, energy and natural resources, and small enterprise development.

R&D budget authority for international affairs
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$223	$208	$199
Agency for International Development			
Science & technology (Central)	95	86	87
Asia and Near East	37	28	32
Science advisor	15	15	15
Latin America	10	17	13
Africa	22	18	8
Private enterprise	(a)	-	-
Program policy coordination	44	44	44

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

ALL OTHER FUNCTIONS

The following five functions represent areas in which R&D activities play a relatively small role: commerce and housing credit; community and regional development; administration of justice; income security; and general government. The function tables are presented in descending order according to their 1989 R&D budget authority funding. Together, the R&D budget authority in 1989 for these five functions accounts for $312 million, which is a 4 percent increase from the 1988 level of $301 million.

R&D budget authority funding for 1989 for these functions is highlighted below:

- Commerce and housing credit R&D funding increased 8 percent, or $10 million, to a level of $131 million. This growth is attributable to an increase in the National Bureau of Standards (Commerce) R&D programs to support development of measurements and standards for superconductors, process and quality control, high-performance composites, fiber optics, and bioprocess engineering.

- Funding for community and regional development decreased 9 percent, or $9 million, from the previous year, to $93 million. About four-fifths of all funding for this function is for the Tennessee Valley Authority (TVA). Most of TVA's funding is for the design, construction, and testing of a demonstration scale atmospheric fluidized-bed combuster at TVA's Shawnee Steam Plant to enable the use of lower grade coals without flue gas desulpherization for better operation of coal-fired steam generator power plants.

- Funding for the administration of justice increased by $12 million, or 29 percent, to $55 million. The additional R&D funds are mostly for the U.S. Customs Service (Treasury) to evaluate the potential for enhancing detection capability through over-the-horizon radar technology.

- Income security decreased 9 percent, or $2 million, below 1988 levels to $18 million.

- General government funding decreased slightly from $16 million to $15 million.

R&D budget authority for commerce and housing credit
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$110	$121	$131
Department of Commerce			
National Bureau of Standards	98	108	118
Engineering measurements and standards	35	37	42
Measurement research and standards	30	35	36
Materials science and engineering	17	19	21
Computer sciences and technology	7	7	9
Research support activities	10	10	10
National Telecommunications and Information Administration	8	9	8
Bureau of the Census	5	4	4

SOURCE: National Science Foundation, SRS

R&D budget authority for community and regional development
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$99	$102	$93
Tennessee Valley Authority	78	79	74
Department of Housing and Urban Development	16	19	19
Housing markets	12	14	14
Housing programs	2	2	2
Fair housing	-	1	1
Safety and standards	(a)	1	1
Local government management	(a)	(a)	(a)
Community and urban development	(a)	(a)	(a)
Research support	2	1	1
Economic Development Administration (Commerce)	5	4	-

R&D budget authority for administration of justice
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$49	$43	$55
Department of Justice	42	34	32
Office of Justice Programs	24	22	19
Federal Bureau of Investigation	12	9	11
Federal Prison System	2	2	2
Drug Enforcement Administration	2	2	1
Immigration and Naturalization Service	(a)	(a)	(a)
Customs Service (Treasury)	7	9	23

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

R&D budget authority for income security
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$25	$20	$18
Department of Health and Human Services	25	20	18
Social Security Administration	13	12	10
Departmental Management	8	5	5
Family Support Administration	3	3	3
Pension Benefit Guarantee Corp	(a)	(a)	(a)

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

R&D budget authority for general government
[Dollars in millions]

	1987 actual	1988 estimate	1989 estimate
Total	$17	$16	$15
Department of Treasury			
Internal Revenue Service	15	15	15
U.S. Mint	2	1	1

SOURCE: National Science Foundation, SRS

APPENDIX: HISTORICAL TRENDS

NOTE: Detailed data for earlier years are not available.

Federal R&D obligations by selected budget function: fiscal years 1955-60
[Dollars in millions]

Function	1955	1956	1957	1958	1959	1960
Total	$2,533	$2,988	$3,932	$4,570	$6,694	$7,552
National defense	2,151	2,535	3,327	3,801	5,556	6,107
Health	67	83	140	177	233	305
All other functions	315	370	465	592	904	1,140

SOURCE: National Science Foundation, SRS

Federal R&D obligations by selected budget function: fiscal years 1961-66
[Dollars in millions]

Function	1961	1962	1963	1964	1965	1966
Total	$9,059	$10,290	$12,495	$14.225	$14,614	$15,320
National defense	7,005	7,238	7,764	7,829	7,342	7,536
Health	405	551	626	728	792	900
Space research and technology	777	1,413	2,812	4,241	4,887	4,976
Energy	373	448	515	571	585	575
General science	137	187	246	277	304	377
Transportation	55	101	142	122	147	251
Natural resources and environment	73	108	120	134	159	189
Agriculture	125	136	146	165	195	201
All other functions	108	107	125	160	203	315

SOURCE: National Science Foundation, SRS

Federal R&D obligations by budget function: fiscal years 1967-77

[Dollars in millions]

Function	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Total	$16,529	$15,921	$15,641	$15,339	$15,543	$16,496	$16,800	$17,410	$19,039	$20,780	$23,450
National defense	8,566	8,275	8,356	7,981	8,110	8,902	9,002	9,016	9,679	10,430	11,864
Health	915	1,021	1,088	1,084	1,288	1,547	1,585	2,069	2,170	2,351	2,629
Space research and technology	4,778	4,304	3,799	3,606	3,048	2,932	2,824	2,702	2,764	3,130	2,832
General science	409	437	433	452	513	625	658	749	813	858	974
Energy	600	657	597	574	556	574	630	759	1,363	1,649	2,562
Natural resources and environment	320	331	323	340	416	479	554	516	624	683	753
Transportation	380	304	404	535	728	558	572	693	635	631	708
Agriculture	218	217	221	238	259	294	308	313	342	383	457
International affairs	18	17	26	32	32	29	28	24	29	42	66
Education, training, employment and social services	154	166	169	164	215	235	290	236	239	255	230
Veterans benefits and services	41	45	50	59	63	69	74	85	95	98	107
Commerce and housing credit	43	48	54	79	90	50	50	51	65	69	71
Administration of justice	(a)	1	5	9	10	23	33	35	44	35	30
Community and regional development	37	44	32	47	65	66	78	82	93	109	101
Income security	48	50	78	136	145	106	106	71	72	48	55
General government	3	5	5	6	7	8	7	9	12	12	13

(a) Less than $500,000.

SOURCE: National Science Foundation, SRS

Federal R&D funding by budget function: fiscal years 1978-89

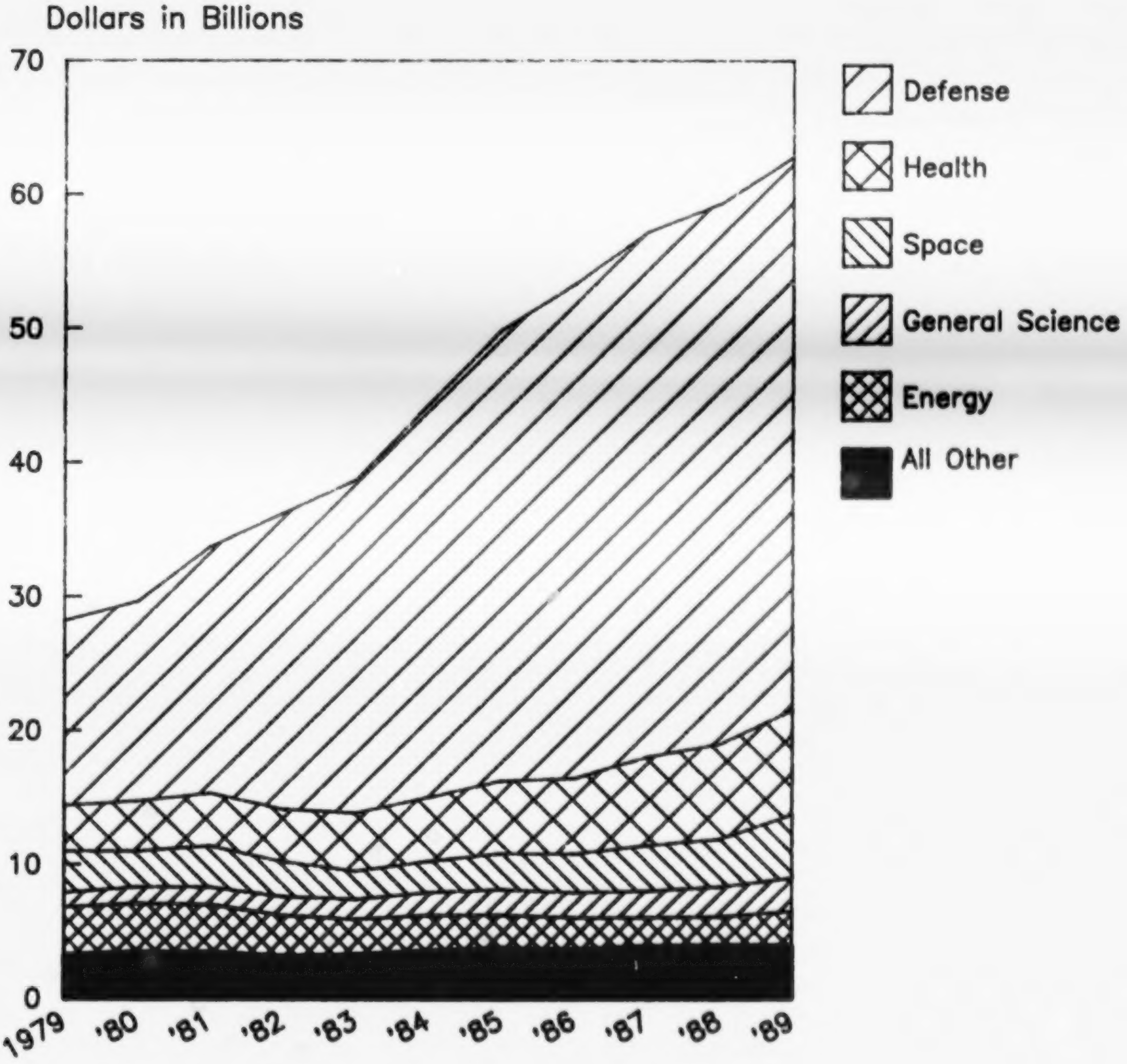
[Dollars in millions]

Function	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988 est	1989 est
Total	$25,976	$28,208	$29,739	$33,735	$36,115	$38,768	$44,214	$49,887	$53,249	$57,069	$59,204	$62,892
National defense	12,899	13,791	14,946	18,413	22,070	24,936	29,287	33,698	36,926	39,152	40,300	41,318
Health	2,968	3,401	3,694	3,871	3,869	4,298	4,779	5,418	5,565	6,556	7,087	7,849
Space research and technology	2,939	3,136	2,738	3,111	2,584	2,134	2,300	2,725	2,894	3,398	3,574	4,733
General science	1,050	1,119	1,233	1,340	1,359	1,502	1,676	1,862	1,873	2,042	2,150	2,533
Energy	3.134	3,461	3,603	3.501	3,012	2,578	2,581	2,389	2,286	2,053	2,126	2,471
Transportation	768	798	887	869	791	876	1,040	1,030	917	908	918	1,064
Natural resources and environment	904	1,010	999	1,061	965	952	963	1,059	1,062	1,133	1,163	1,061
Agriculture	501	552	585	659	693	745	762	836	815	822	876	830
Education, training, employment and social services	345	354	468	298	228	189	200	220	248	267	290	295
Veterans benefits and services	111	123	126	143	139	157	218	193	183	215	210	206
International affairs	57	117	125	160	165	177	192	210	211	223	208	199
Commerce and housing credit	77	93	101	106	104	107	110	114	111	110	121	131
Community and regional development	92	127	119	104	63	44	46	50	88	99	102	93
Administration of justice	44	47	45	34	31	37	24	47	41	49	43	55
Income security	67	57	47	43	32	32	26	21	14	25	20	18
General government	20	23	22	22	10	6	8	17	14	17	16	15

Note: Data for 1978-87 are shown in actual budget authority. Data for 1988 and 1989 are estimates based on the FY 1989 budget.

SOURCE: National Science Foundation, SRS

Federal R&D by Major Function
Cumulative



SOURCE: National Science Foundation, SRS

Budget authority for basic research by function: fiscal years 1978-89

[Dollars in millions]

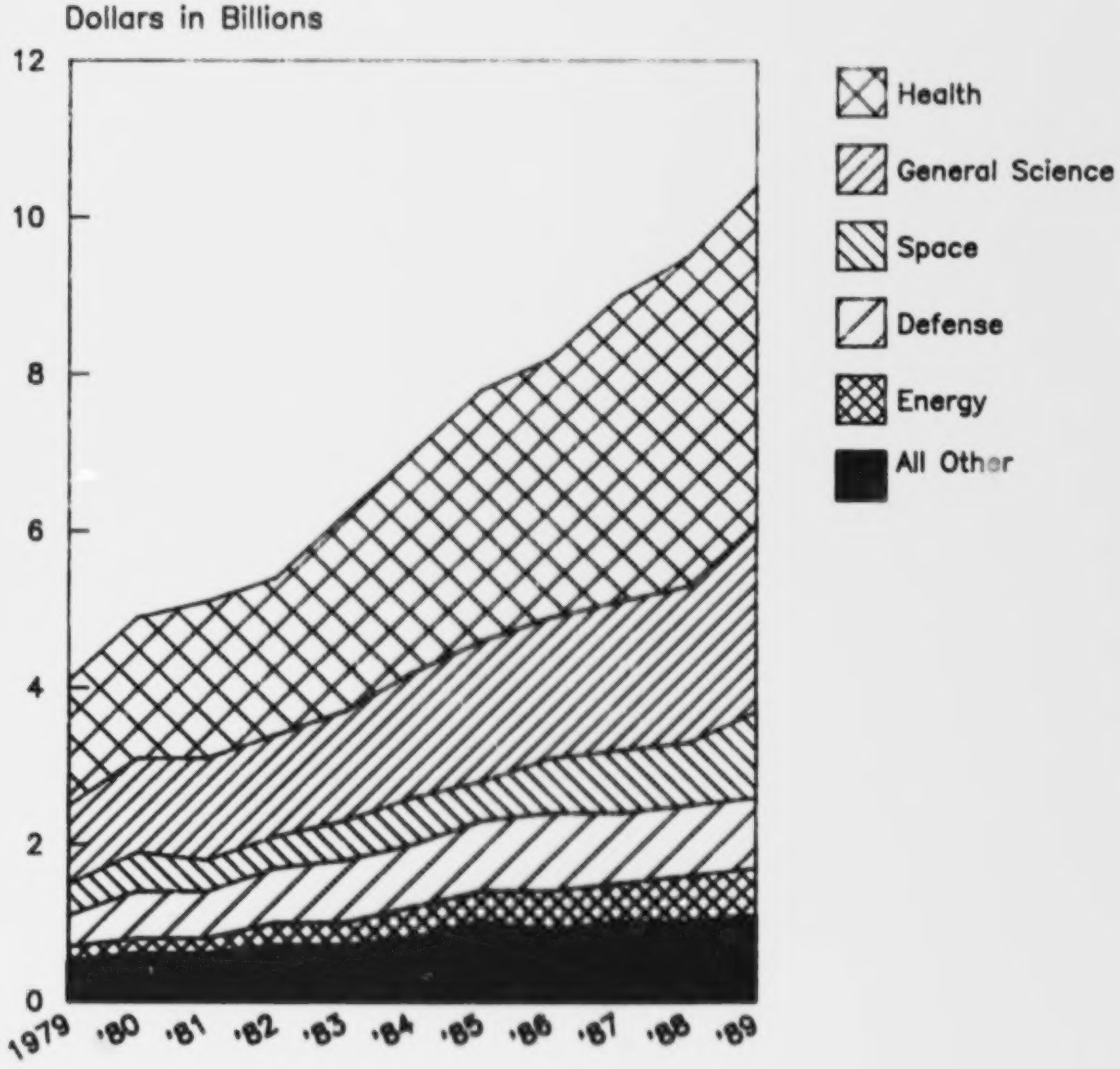
Function	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988 est	1989 est
Total	$3,665	$4,108	$4,716	$5,107	$5,305	$6,247	$7,072	$7,810	$8,193	$9,021	$9,530	$10,319
Health	1,246	1,579	1,761	1,951	1,953	2,475	2,813	3,243	3,324	3,851	4,153	4,253
General science	962	1,026	1,152	1,256	1,296	1,439	1,606	1,779	1,795	1,942	2,045	2,415
Space research and technology	412	440	482	445	434	501	646	498	737	843	849	1,062
National defense	320	365	552	610	696	788	845	856	960	900	907	924
Energy	157	172	200	220	260	320	365	428	456	511	568	571
Agriculture	197	222	246	281	295	326	353	406	390	397	417	418
Transportation	70	75	79	89	102	117	125	255	184	231	226	329
Natural resources and environment	207	131	136	131	139	156	192	206	204	206	217	208
Education, training, employment and social services	57	59	61	66	78	70	77	86	83	78	83	84
Commerce and housing credit	9	10	15	17	17	19	20	23	26	26	27	27
Veterans benefits and services	9	10	14	15	13	14	15	15	15	17	19	17
Administration of justice	10	10	9	5	4	4	5	4	5	8	9	4
General government	-	(a)	(a)	3	2	3	3	4	5	4	5	3
Community and regional development	8	8	8	5	7	6	5	6	6	4	4	3
International affairs	(a)	-	-	12	10	10	3	4	5	3	2	1
Income security	2	1	1	3	-	-	-	-	-	-	-	-

(a) Less than $500,000.

Note: Data for 1978-87 are shown in actual budget authority. Data for 1988 and 1989 are estimates based on the FY 1989 budget.

SOURCE: National Science Foundation, SRS

Federal Basic Research by Major Function
Cumulative



Fiscal Year

SOURCE: National Science Foundation, SRS

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